



Habit vs. intention in the prediction of future behaviour: The role of frequency, context stability and mental accessibility of past behaviour

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This research examined the role of habit and intention in the prediction of future behaviour by analysing that past behaviour frequency moderates the intention–behaviour relationship to the extent that the context in which the behaviour was performed is stable. In two correlational studies, it was found that habit interacted with intention when context stability was taken into account and not when merely past behaviour frequency was considered: intentions guided future behaviour when habits were weak (low frequency or unstable context), while this was not the case when habits were strong (high frequency and stable context). A third exploratory study investigated and confirmed the idea that, if habitual goal-directed behaviour is directly activated by the context, mental accessibility of the behaviour (i.e. the ease of accessing the goal-directed behaviour in memory) moderates the intention–behaviour relation in a similar way. These findings are discussed against the background of current research on goal-directed habits and the cognitive processes underlying them.

People are creatures of habit. Many of their everyday goal-directed behaviours are performed in a habitual fashion, the transport mode and route one takes to work, one's choice of breakfast. Habits are formed when using the same behaviour frequently and consistently in a similar context for the same purpose (Ouellette & Wood, 1998; Ronis, Yates, & Kirscht, 1989; Verplanken & Aarts, 1999). Current work on habits posits that the repetitive nature of goal-directed behaviour causes the mental representation of the behaviour to be directly elicited when encountering the given context (Aarts & Dijksterhuis, 2000a; Bargh, 1990). Accordingly, conscious effort to plan and initiate goal-directed behaviour becomes redundant. That is, people are able to perform goal-directed behaviour without forming an explicit intention because the behaviour is

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directly mentally accessed in the context at hand as a result of frequently and consistently having performed that behaviour in the past.

The role of habits has been a key issue of investigation in social psychological research on attitude-behaviour models (Eagly & Chaiken, 1993). Whereas frequency of past behaviour is generally acknowledged to play a significant role in the prediction of goal-directed behaviour, there is some debate about the way in which measures of past behaviour represent habitual control and contribute to the prediction of future behaviour over and above intention (Ajzen & Fishbein, 2000; Ouellette & Wood, 1998; Verplanken, & Aarts 1999). Adding to this discourse, the present research analysed the role of habits by exploring how frequency, context stability and mental accessibility of past behaviour moderate the relation between intention and future behaviour.

An important contribution in the field of habits and attitude-behaviour models was made by Bentler and Speckart (1979), who investigated students' consumption of alcohol and marijuana. They suggested that such actions become habitual over time, and importantly, that these actions can be instigated without mediation of intentions. Indeed, the results of their study clearly showed that a measure of habit (obtained by self-reported frequency of behaviour in the past) does predict future behaviour over and above intentions, suggesting that such behaviour is initiated without much deliberation and thought. The work of Bentler and Speckart (1979) has been replicated by many other investigators in a wide variety of behavioural domains, such as students' class attendance, drinking milk, eating chips and other junk food, physical exercise, condom use, drug use, and seat belt use (see Ouellette & Wood, 1998, for a meta-analysis). The direct influence of frequency of past behaviour on future behaviour also underscores the behaviourists' maxim that behaviour is largely influenced by habit. However, the direct relation between past and future actions is not really informative in understanding when goal-directed behaviour is best predicted by habits or intentions. That is, it tells us that we simply do the things as we did them before.

Interaction between habit and intention

In a more sophisticated attempt to conceptualize the relationship between habitual and intentional control of goal-directed behaviour, Triandis (1980) proposed a model suggesting that habit and intention *interact* in their prediction of later behaviour - instead of predicting behaviour over and above a measure of intention. In fact, Triandis hypothesized that when the same behaviour is more frequently executed in the past and increases in habit strength, it is less guided by intention to perform that behaviour. In this sense, habits are automatic to the extent that the behaviour is no longer predicted (or guided) by intentions. Thus, habit strength may moderate the relationship between reason-based concepts (intentions) and subsequent goal-directed behaviour (see also, Ronis *et al.*, 1989). The stronger the habit, the weaker the intention-behaviour relationship.

Whereas the moderating role of habits in the intention-behaviour relationship offers a promising perspective on testing the habitual nature of goal-directed behaviour, there are only a few studies that report this effect (Ferguson & Bibby, 2002; Montana & Taplin, 1991; Verplanken, Aarts, Van Knippenberg, & Moonen, 1998; Wood, Tam, & Querrero Witt, 2005). In one of the first studies on this issue, Montano and Taplin examined women's behaviour to engage in mammogram testing to prevent breast cancer. They investigated the contribution of frequent and consistent mammogram testing in the past to the prediction of future behaviour above the intention to get a mammogram done.

They established an interaction between habit and intention such that women with larger numbers of previous mammograms were less likely to base behaviour on their intention than women with fewer previous mammograms.

However, it has been argued that past behaviour frequency may not represent the most optimal measure to examine how habit strength moderates the relation between intention and behaviour (Ouellette & Wood, 1998; Verplanken & Aarts, 1999). In a different attempt to study the role of habits in goal-directed behaviour, Aarts and colleagues developed the Response Frequency measure which they tested in the realm of travel-mode behaviour, a behaviour that can be quite repetitive (Aarts, Verplanken, & Van Knippenberg, 1997, 1998; Verplanken *et al.*, 1998). They asked their participants to quickly mention the mode of transport they would use to reach several travel destinations. As an index of habit strength, they counted the number of times the same mode of transport (e.g. car) was nominated across the set of travel destinations. The basic idea behind this measure of habit is that when, for example, the car has been used frequently in the past to travel to various destinations and thus has become habitual, this mode in general comes to mind more often. This measure of habit revealed several interesting aspects as to the decision-making process of travel behaviour. For instance, the habit measure negatively correlated with the depth of information search and use preceding people's travel-mode choices. Moreover, it was found that this habit measure interacted with intention in the prediction of future travel behaviour: when habit was strong intention did not predict future behaviour, whereas behaviour was predicted by intentions when habit was weak. Taken together, then, these results showed that the decision-making process underlying goal-directed behaviour ceases to exist when habits grow in strength. Or in other words, more practice leads people to initiate goal-directed behaviour without much thought and consideration.

The role of context stability

Whereas the studies alluded to above suggest that control of goal-directed behaviour shifts from an intentional to a more habitual (non-intentional) process when the behaviour is performed more often in the past, several researchers have argued that frequency may not be the sole cause of habit formation. What also matters is the consistency of performing the behaviour (e.g. Aarts & Dijksterhuis 2000a; Bargh, 1990; Ouellette & Wood, 1998; Sheeran *et al.*, 2005; Verplanken & Aarts, 1999; Wood *et al.* 2005). This consistency aspect basically refers to the stability of the context (i.e. place, time, and situation) in which the behaviour has been executed in the past. The idea that the stability of the context plays a role in the establishment of habits is based on the assumption that people are sensitive to changes in this context. These changes encourage them to consider social beliefs and evaluations (such as expressed in the model of planned behaviour; Ajzen, 1991) that are relevant to determine the proper course of action to attain goals in the context at hand. Accordingly, habits are supposed to be formed when the goal-directed behaviour is repeatedly performed in the same place, at the same time and in the same situation, as the beliefs and evaluations are less likely to be consulted when one performs the same behaviour in the same context over and again (Aarts, Paulussen, & Schaalma, 1997). In that case, the context becomes strongly and exclusively linked to the mental representation of the behaviour and hence, the context is capable of eliciting the performance of the behaviour directly without conscious intent (see also Barnett & Ceci, 2002; Heckhausen & Beckmann, 1990).

The line of reasoning addressed above suggests that people are more likely to rely on intentional processes when they rarely perform the same behaviour in the same

context, or regularly perform the same behaviour in different contexts, as the context is either less strongly or less uniquely linked to the behaviour. For example, a person drinking white wine sporadically during the past 4 weeks at the same place (e.g. a pub) in the same social setting (e.g. being with friends on a Friday night) may rely on conscious intention to initiate the behaviour to a similar extent as a person frequently drinking white wine in the same period at different places (e.g. a pub, restaurant, at home) in different social settings (e.g. being with friends, having a business meeting, spouse's birthday party). Thus, the extent to which a person is supposed to produce goal-directed behaviour in a habitual way is a multiplicative function of the frequency of past behaviour in a period of time and context stability of the behaviour.

In acknowledging the importance of the context for habits to emerge, Ouellette and Wood (1998; Wood *et al.*, 2005) proposed that a measure of habit strength should reflect the extent to which behaviour is performed both *frequently* and in a *stable context*. This line of argumentation suggests that a measure of frequency of past behaviour is more likely to moderate the intention-behaviour relationship when the stability aspect is taken into account. In testing this idea for several mundane behaviours (such as watching TV or reading a newspaper), Wood and colleagues estimated habit strength by multiplying a measure of past behaviour frequency with a measure of context stability (that is, the extent to which the behaviour was performed in a similar context). This yielded a relatively continuous habit scale that potentially could range from low to high, with higher scores reflecting high frequency in stable context (i.e. strong habit) and lower scores reflecting either infrequent performance or unstable variable context (i.e. weak or no habit). Their results showed that this habit scale interacted with a measure of intention in the prediction of future behaviour. Although Wood and colleagues did not directly compare the effects of their habit scale with the traditional habit measure of past behaviour frequency, their findings suggest that information about context stability provides an important contribution in disentangling the role of intention and habit in the prediction of future behaviour.

Present research

In an attempt to extend previous work, the present research tested the moderating role of habit in the intention to future behaviour link by considering the stability of the context in which past behaviour was frequently performed. Moreover, we compared the results of the habit scale proposed by Wood *et al.* (2005) with a measure of past frequency in which context stability was not taken into account. We hypothesized that past behaviour frequency would not moderate the intention-behaviour relation, while the habit scale would as proposed by Wood *et al.* (2005). For this purpose, we conducted two studies in which we first measured past behaviour frequency, context stability, and intention. Subsequently, respondents were revisited 4 weeks later and their actual behaviour was assessed. This allowed us to test and compare the moderating role of the measure of past behaviour frequency with the habit scale in the intention-behaviour relation. We examined this notion for specific mundane habits, e.g. drinking alcohol when being out (e.g. Wood *et al.* 2005), as well as for a more generalized habit (cycling behaviour to different locations, e.g. Aarts *et al.*, 1998; Verplanken *et al.*, 1998).

In a third exploratory study, we aimed to extend previous research by studying the role of mental accessibility of goal-directed behaviour (i.e. the ease of accessing the goal-directed behaviour in memory) in moderating the intention-behaviour relation.

If habitual behaviour is directly activated by the context, mental accessibility of the behaviour should moderate the relation between intention and future behaviour: intention will only predict behaviour when the accessibility of the representation of the habitual goal-directed behaviour is low and not when the accessibility is high (see also Aarts & Dijksterhuis, 2000a, b).

STUDY I

In the first study, we assessed participants' frequency and context stability of past behaviour and, conform Wood *et al.* (2005), we combined these two factors into an index of habit strength. Intention, past behaviour frequency and context stability were measured for three different behaviours: snacking, drinking milk, and drinking alcohol. After 4 weeks, the participants were asked to indicate how often they actually had performed the behaviour in the weeks after the first measurement. In line with previous work, we hypothesized that both the frequency measure and the habit strength scale will predict future behaviour over and above intention. However, based on Wood *et al.*'s (2005) idea about the importance of context stability, we expected that the habit strength scale will interact with intention in the prediction of future behaviour, while such interactive pattern is less likely to emerge when merely the measure of frequency of past behaviour is used. To examine whether the potential interaction effect between habit strength and intention is the result of a combined effect of past behaviour frequency and context stability (i.e. behaviour repeatedly performed in a stable context) and not due to context stability alone, we performed analyses in which we tested the interaction between context stability and intention in the prediction of future behaviour as well.

Method

Participants and design

Hundred and thirty-nine students (110 females and 29 males) of Utrecht University participated in exchange for € 5. The study consisted of a longitudinal design with two measurements. The first measurement (assessing intention, frequency of past behaviour and context stability of three everyday goal-directed behaviours: snacking, drinking milk, and drinking alcohol) took place 4 weeks before the second measurement (in which the behaviours were assessed again).

Measurement one

The first measurement was conducted in separate cubicles and all the necessary instructions were provided by means of the computer. Participants were told that several questions were going to be asked about their everyday behaviours. For each behaviour, the participants were asked to indicate their *intention* to perform the behaviour in the next 4 weeks on a 9-point scale ranging from 1 'no, not at all' to 9 'yes, certainly'. Furthermore, *frequency of behaviour* in the past 4 weeks was assessed by asking respondents to indicate how often they performed each behaviour on a 9-point scale ranging from 0 'never' to 8 'very frequently'.

Stability of the context was explained as the degree to which the time (e.g. time of day), the place (the physical location), and the situation (the circumstances,

e.g. weather, other people, etc.) was similar each time the behaviour was carried out. Participants were told that if these three aspects always differed, i.e. the behaviour was executed in different places, at different times, and in different situations, the context in which past behaviour was executed was unstable. However, when these three aspects are similar each time the goal-directed behaviour is performed, then the context is stable. Between these two end-points, stability may differ to the extent that each aspect is the same or not when performing the behaviour (see also Wood *et al.* 2005). Stability of the context in which the behaviour was performed was assessed on a 9-point scale ranging from 1 'unstable' to 9 'stable'. For each specific behaviour, a habit strength scale was calculated by multiplying past behaviour frequency with context stability in which the past behaviour was performed. This yielded a relatively continuous habit scale that could range from 0 to 72, with higher scores reflecting high frequency in a stable context (i.e. strong habit) and lower scores reflecting infrequent performance or unstable, variable context (i.e. weak or no habit). Finally, participants' e-mail addresses were written down, enabling us to link their data to the second measurement (which they did not know about in advance).

Measurement two

In the second measurement, participants' actual behaviour in the 4 weeks following the first measurement was assessed. As they were asked to participate during a lecture, the data were collected by means of paper-and-pencil. The questions concerned the same behaviours as in the first measurement. Participants were asked to indicate how often they had performed the behaviour in the past 4 weeks on a 9-point scale ranging from 0 'never' to 8 'very often'. Finally, e-mail addresses were collected again.

Results and discussion

To compare the role of the measure of past behaviour frequency and context stability with the habit strength scale in moderating the prediction of future behaviour by intention, three separate regression analyses were conducted per behaviour. We conducted hierarchical regression analyses in which the independent variables were zero centred before analyses (Dunlap & Kemery, 1987) to investigate the interaction between intention and either frequency of past behaviour, context stability, or habit strength in the prediction of later behaviour. For each behaviour, intention and either past behaviour, context stability, or habit strength were entered in Step 1, and the interaction of intention by past behaviour, context stability, or habit strength was entered in Step 2. The correlations between future behaviour, intention, past behaviour, and context stability are presented in Table 1a and the results of the three analyses (the frequency of past behaviour and context stability measures vs. the habit strength scale) are presented in Tables 1b-d, respectively. Below, we present the results of these analyses for each behaviour separately.

Snacking

A strong main effect of past behaviour frequency was found as well as a smaller effect of intention. No interaction effect was found between past behaviour frequency and intention to perform the behaviour. Both factors were predictive of later behaviour, but did not interact in the prediction of later behaviour. Similar effects were found for

Table 1a. Correlations between behaviour 4 weeks later from past behaviour, context stability, habit strength, and intentions ($N = 139$)

	Future behaviour	Intentions	Past behaviour	Context stability
<i>Snacking</i>				
Future behaviour	–	.46	.57	.31
Intentions		–	.63	.39
Past behaviour			–	.32
Context stability				–
<i>Drinking milk</i>				
Future behaviour	–	.80	.84	.60
Intentions		–	.90	.65
Past behaviour			–	.66
Context stability				–
<i>Drinking alcohol</i>				
Future behaviour	–	.65	.75	.45
Intentions		–	.77	.60
Past behaviour			–	.58
Context stability				–

Note. All correlations, $p < .001$.

Table 1b. Hierarchical regression analysis predicting behaviour 4 weeks later from past behaviour and intentions to perform the behaviours ($N = 139$)

	β	t	p
<i>Snacking</i>			
Intentions	0.16	1.78	.078
Past behaviour	0.47	5.29	<.001
Intentions \times past behaviour	–0.11	–1.43	ns
<i>Drinking milk</i>			
Intentions	0.21	2.00	.053
Past behaviour	0.65	6.16	<.001
Intentions \times past behaviour	–0.05	–0.75	ns
<i>Drinking alcohol</i>			
Intentions	0.18	2.07	.040
Past behaviour	0.61	7.04	<.001
Intentions \times past behaviour	0.014	0.13	ns

stability of the context and intention to perform the behaviour indicating that both factors were predictive of later behaviour, but did not interact. Habit strength and intentions were also both related to later behaviour. However, in line with the expectation, a significant interaction effect between these two components was found. To interpret the interaction, we computed simple regression slopes of intention at varying levels of habit strength (Cohen, Cohen, West, & Aiken, 2003). To identify the levels of habit and intention to use in the simple regressions, we estimated scores one standard deviation above the mean and one standard deviation below the mean. This allowed us to test the relation between intention and actual snacking behaviour for participants with relatively stronger and weaker snacking habits (see also Figure 1a). The analysis showed that the slope for intention–behaviour relation was significant and

Table 1c. Hierarchical regression analysis predicting behaviour 4 weeks later from context stability and intentions to perform the behaviours ($N = 139$)

	β	t	p
Snacking			
Intentions	0.40	4.83	< .001
Context stability	0.15	1.89	.07
Intentions \times context stability	0.001	0.015	ns
Drinking milk			
Intentions	0.70	10.49	< .001
Context stability	0.14	2.12	.04
Intentions \times context stability	0.06	1.22	ns
Drinking alcohol			
Intentions	0.59	7.29	< .001
Context stability	0.10	1.18	ns
Intentions \times context stability	0.05	0.50	ns

Table 1d. Hierarchical regression analysis predicting behaviour 4 weeks later from habit strength and intentions to perform the behaviours ($N = 139$)

	β	t	p
Snacking			
Intention	0.16	1.73	.086
Habit strength	0.48	5.34	< .001
Intention \times habit strength	-0.22	-2.30	.023
Drinking milk			
Intention	0.51	6.43	< .001
Habit strength	0.35	4.43	< .001
Intention \times habit strength	-0.23	-2.27	.025
Drinking alcohol			
Intention	0.45	5.71	< .001
Habit strength	0.32	4.03	< .001
Intention \times habit strength	-0.15	-1.12	.26

positive when snacking habit was weak, $b = 0.29$, $p = .007$, while the slope was non-significant when snacking habit was strong, $b = -0.13$, *ns*.

Drinking milk

The analyses for the act of drinking milk showed that frequency of past behaviour and intention were both related to later behaviour, but did not interact. Stability of the context and intention to perform the behaviour were also both predictive of later behaviour, but did not interact as well. Habit strength and intention, on the other hand, did show main effects as well as an interaction effect. Again, simple regression analyses were conducted to interpret the interaction effect. Simple slope analyses for intention on varying levels of habit strength showed that the slope was significant and positively related to behaviour when the milk habit was weak, $b = 0.59$, $p < .001$, but was not related when the milk habit was strong, $b = -0.005$, *ns* (see also Figure 1b).

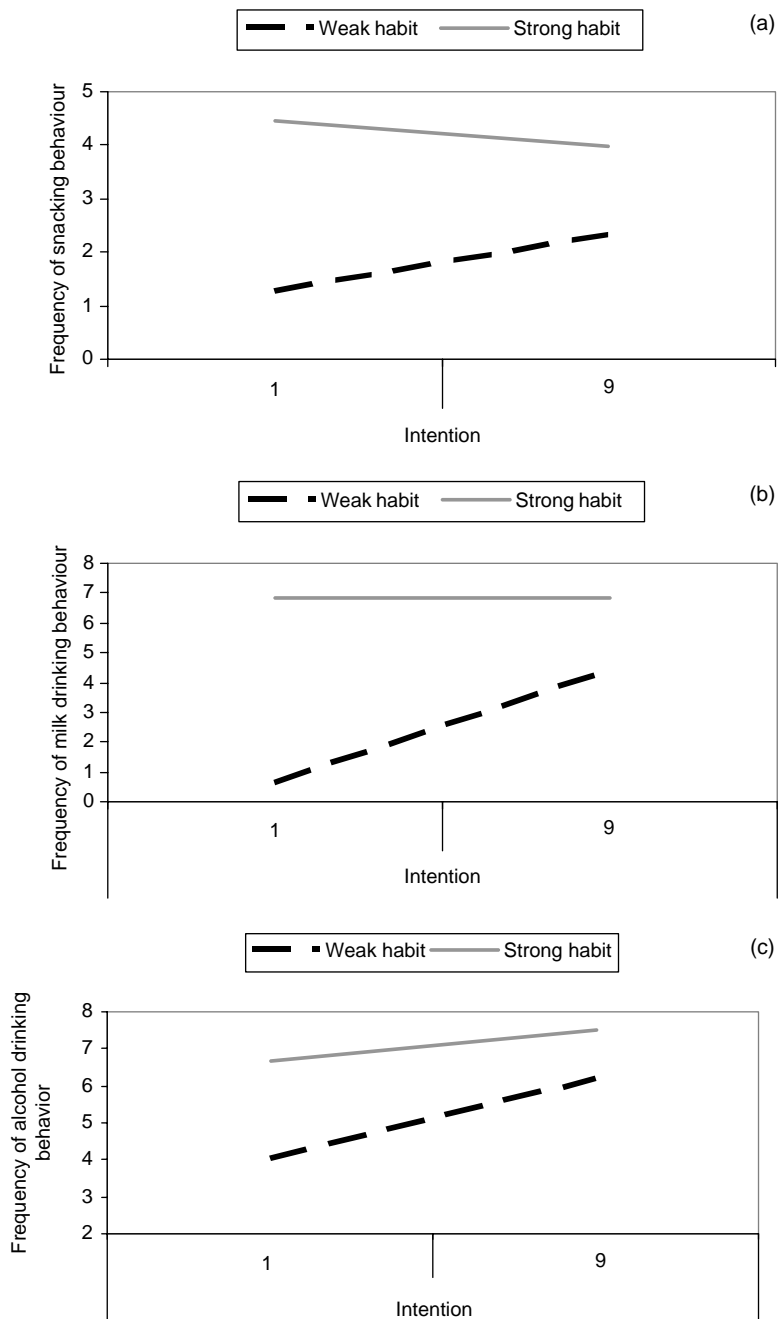


Figure 1. (a) Decomposition of two-way interaction: frequency of snacking behaviour over 4 weeks as a function of intentions to perform the behaviour and snacking habit strength. (b) Decomposition of two-way interaction: frequency of drinking milk behaviour over 4 weeks as a function of intentions to perform the behaviour and milk habit strength. (c) Decomposition of two-way interaction: frequency of drinking alcohol over four weeks as a function of intentions to perform the behaviour and alcohol drinking habit strength.

Drinking alcohol

Frequency of past behaviour and intention to drink alcohol are both predictive of future alcohol drinking, but did not interact. The analyses with context stability and intention showed that only intention was predictive of later behaviour and again, no interaction was found. Habit strength and intention were both related to later behaviour. Although the interaction effect was rather weak (i.e. non-significant), it was similar to the pattern of results of snacking and drinking milk. Therefore, we also conducted further simple slope analyses to interpret the interaction effect for intention on different levels of habit strength. The results were consistent with snacking and drinking milk: the regression slope for intention was significant when drinking alcohol was a weak habit, $b = 0.42$, $p < .001$ and was non-significant when it was a strong habit, $b = 0.16$, *ns*, see also Figure 1c.

Taken together, the findings of the first study indicate that measures of frequency of past behaviour, context stability, habit strength, and intention were all predictors of the three single behaviours under investigation (albeit that the weight of the components differed across the behaviours). Importantly, the frequency or the context stability measures alone did not interact with the intention in the prediction of behaviour, showing that frequency of past behaviour and context stability separately were no optimal measures to disentangle the habitual and intentional control of behaviour. However, further analyses revealed that frequency of past behaviour moderated the intention-behaviour relationship when information about the context stability was directly considered in this measure. Specifically, our data suggests that only under conditions of high frequency and high context stability the intention-behaviour relation was absent. This interaction effect was significant for snacking and drinking milk, while the pattern of results (although non-significant) also showed up for drinking alcohol.¹

STUDY 2

The purpose of the second study was to replicate and extend the findings of Study 1 to another behavioural domain: travel behaviour. Earlier studies have shown that habits play a prominent role in travel behaviour (Aarts *et al.*, 1997, 1998; Bamberg & Schmidt, 2003; Matthies, Kuhn, & Klöckner, 2002; Verplanken *et al.*, 1998). Several different measures have been used to examine this idea, such as frequency of past behaviour and the Response Frequency measure. These measures have been shown to predict transport-mode choice behaviour over and above intentions. More importantly, Verplanken *et al.* showed that their Response Frequency measure and frequency of past behaviour both interacted with a measure of intention in the prediction of future behaviour. However, the behaviour under investigation in their study, i.e. car use among inhabitants of a village commuting to a near city, is likely to be performed in a stable context: place, time, and situation are always the same. Hence, frequency of past behaviour may have represented an optimal measure of habit strength, and hence, this measure interacted with intention in the prediction of future travel behaviour.

In Study 2, we also examine travel behaviour but here we focus on cycling behaviour among students for several travel goals in a Dutch town. It is likely that for some students

¹ A hierarchical regression analysis was also conducted to test the contribution of the three-way interaction between frequency of past behaviour, context stability, and intention in the prediction of later behaviour for each behaviour separately. These analyses provided the following contributions of the three-way interaction: for snacking, $\beta = 0.095$, $t = 0.77$, *ns*; for drinking milk $\beta = -0.59$, $t = -3.26$, $p = .001$; and for drinking alcohol, $\beta = -0.062$, $t = -0.25$, *ns*.

this behaviour is performed in a less stable context than for others. In other words, there may be variability in stability as to the place, time, and situation in which the bicycle was previously used. Following the present line of reasoning and the findings of Study 1, we assume that only those students who have cycled frequently in a stable context during the past 4 weeks will have developed a strong cycle habit. To test this idea, we examined in Study 2 cycling behaviour to various short-distance destinations. For each destination, intention, past behaviour frequency, and context stability towards bicycle use were measured. After 4 weeks, we measured how often participants actually had used the bicycle to reach the several destinations in the weeks following the first measurement. Our hypotheses were similar to Study 1: the frequency of past behaviour measure will predict future behaviour over and above intention, while the habit strength scale will interact with intention in the prediction of behaviour. In line with the findings of Study 1, the frequency and context stability measures alone are not expected to show an interaction effect with intention in the prediction of future behaviour.

Method

Participants and design

Eighty students (61 females and 19 males) of Utrecht University participated in exchange for € 5. Because bicycle travel behaviour to various destinations in Utrecht was examined, only participants who were living in Utrecht at the moment of the study were recruited to participate. Again the study consisted of a longitudinal design with two measurements. The first measurement (assessing intention, frequency of past behaviour, and context stability as to cycling behaviour to various destinations in Utrecht) took place 4 weeks before the second measurement.

Measurement one

The first measurement was conducted on computers in separate cubicles and all the necessary instructions were presented on the screen. Participants were told that they were going to fill out a survey that aimed to investigate travel behaviour of students. They were told that six different travel goals were part of the survey, and that these travel destinations were all short-distance trips that could easily be done with the bicycle. Prior to the first measurement, a pilot test was conducted to ensure that all participants perceived the bicycle to be a realistic mode of transport to travel to the different destinations (i.e. an instrumental means for attainment of the goal). The survey consisted of questions concerning cycling behaviour to different travel locations: their *past behaviour*, the *stability of the context* in which the behaviour was executed, and their *intention* to perform the behaviour in the next 4 weeks (see also Study 1). Different from the first study, we now used a frequency estimation measure in the first measurement: participants had to indicate the number of times they had cycled to each destination in the past 4 weeks. The remaining variables were both measured on a 9-point scale: their intention ranging from 1 'no, not at all' to 9 'yes, certainly', and the stability of the context ranging from 1 'unstable' to 9 'stable'. Finally, participants were asked to write down their e-mail address and their phone number to contact them for the next measurement.

Measurement two

The second measurement was conducted to measure actual cycling behaviour in the 4 weeks following the first measurement. Participants were asked to indicate how often

they had used their bicycle to reach the several travel goals on a 9-point scale ranging from 0 'not at all' to 8 'very often'.

Results and discussion

Habit strength was again construed by multiplying past behaviour frequency with context stability (a high score indicates a strong habit) for each destination separately. As cycling behaviour to several destinations was measured, we calculated Cronbach's alpha for the measures of intention to cycle, frequency of past cycling behaviour, stability of the context in which past behaviour was executed, strength of cycling habit, and future behaviour to ensure that we measured generalized cycling behaviour across the various short-distance trips (cf. Aarts *et al.*, 1998; Verplanken *et al.*, 1998). All alphas were larger than .70, indicating satisfactory internal consistency. Subsequently, we calculated a mean score for each of the four measures.

Three separate hierarchical regression analyses were conducted to compare the past behaviour frequency and context stability measure with the habit scale measure in moderating the prediction of future behaviour by intention. In the first analysis frequency of past behaviour and intention were tested, in the second analysis context stability and intention were tested, and in the third analysis habit (the composite measure of frequency and context stability) and intention were tested. All independent measures were zero centred before analyses, in which intention and either past behaviour, context stability, or habit were entered in Step 1, and the interaction was entered in Step 2. The correlations between the variables are presented in Table 2a and the results of the analyses are presented in Table 2b. Frequency of past behaviour and intention to cycle were both related to later behaviour. In the second analysis, it was found that context stability was not predictive of later behaviour while intentions were related. However, these factors – that is, frequency of past behaviour and intention as well as context stability and intention – did not interact in their prediction of later behaviour. Hence, these results suggest that people cycle more when they have done so repeatedly before and when their intention to cycle is stronger.

The significant main effect of habit and intention (third analysis) showed that both factors were positively related to later behaviour. More importantly, the interaction between habit and intention was significant. In concurrence with Study 1, we conducted further simple slope analyses for intention at varying levels of habit strength to interpret the interaction effect. To identify the levels of habit and intention to use in the simple regressions, we estimated scores one standard deviation above the mean and one standard deviation below the mean. This allowed us to test the relation between cycling and intention to cycle for participants with stronger and weaker habits, see also Figure 2. The analyses showed that the slope of the regression line for later behaviour was positive when habit was weak, $b = 0.44$, $p < .001$. However, the regression slopes were non-significant when habit was strong, $b = -0.14$, *ns*. Hence, intentions were not indicative of later behaviour when the habit was strong, or in other words later behaviour was related to intentions when the cycling habit was weak.²

The results of Study 2, then, replicate and extend those of Study 1. First, we demonstrated that a frequency measure of past behaviour and a context stability

² Similar to Study 1, we also conducted a hierarchical regression analysis to test the three-way interaction between frequency of past behaviour, context stability, and intention in the prediction of later cycling behaviour. This analysis yielded the following result for the three-way interaction: $\beta = -0.36$, $t = -2.00$, $p = .050$.

Table 2a. Correlations between cycling behaviour 4 weeks later from past behaviour, context stability, habit strength, and intentions ($N = 80$)

	Future behaviour	Intentions	Past behaviour	Context stability
Future behaviour	–	.58*	.59*	.26**
Intentions		–	.62*	.49*
Past behaviour			–	.42*
Context stability				–

Note. * $p < .001$; ** $p < .05$.

Table 2b. Hierarchical regression analysis predicting cycling behaviour 4 weeks later from past behaviour, context stability, habit strength, and intentions ($N = 80$)

Variable	β	t	p
Intentions	0.25	2.41	.019
Past behaviour	0.54	5.27	<.001
Intentions \times past behaviour	–0.09	–0.89	ns
Intentions	0.59	5.55	<.001
Context stability	–0.03	–0.27	ns
Intentions \times context stability	–0.01	–0.12	ns
Intentions	0.35	3.37	.001
Habit strength	0.40	3.91	<.001
Intentions \times habit strength	–0.24	–1.98	.05

measure separately did not moderate the intention–behaviour relation. However, we showed that this interaction effect emerged when information about the stability of performing the behaviour was directly combined with the frequency of past behaviour into the habit index proposed by Wood *et al.* (2005). Furthermore, we established this effect for another type of goal-directed behaviour – travel-mode choice behaviour – that has been previously shown to be guided by habits.

STUDY 3

So far, the findings of two studies indicate that intentions do not predict goal-directed behaviour when the behaviour is frequently performed in stable context in the past, and hence has become habitual. These findings may have important implications for our understanding of the mental processes underlying the habitual control of goal-directed behaviour. Specifically, our results suggest that the mental representation of the goal-directed behaviour is directly triggered by the context when that behaviour is frequently and consistently performed in that context and, as a consequence, guides behaviour in the context at hand without the mediation of intention. This notion concurs with recent evidence obtained in the area on automatic goal-directed behaviour (Bargh & Chartrand, 1999; Custers & Aarts, 2005; Moskowitz, Li, & Kirk, 2004). Most research in this field is based on Bargh's auto-motive model (Bargh, 1990) that proposes that goals and their enactment can be automatically controlled by the environment only if the person repeatedly and consistently chooses to pursue the same goal-directed behaviour in the

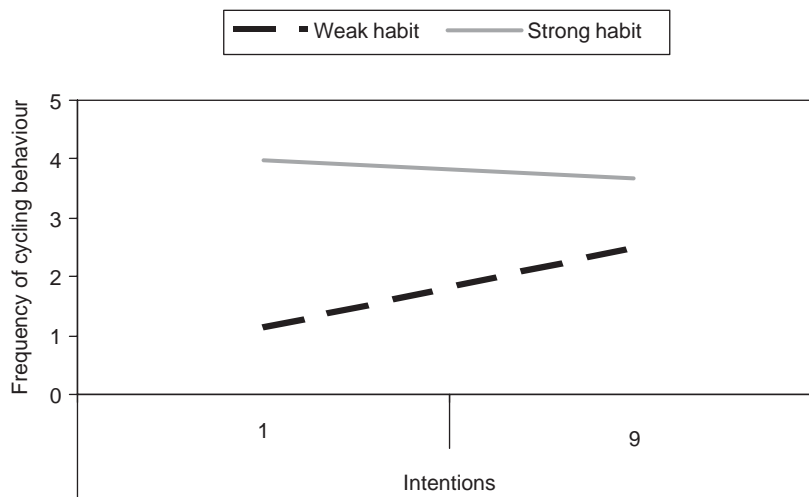


Figure 2. Decomposition of two-way interaction: frequency of past cycling behaviour to various travel locations as a function of intentions to perform the behaviour and the habit strength to cycle to the various locations.

same environment. As Bargh and Chartrand note: 'Initially, conscious choice and guidance are needed to perform the desired behaviour . . . But to the extent . . . the same goal and plan are chosen in that situation, conscious choice drops out as it is not needed' (p. 468). In other words, goal-directed behaviour is conditional on forming explicit intentions to the extent that the behaviour can be directly mentally accessed as a result of frequently and consistently having performed that behaviour in the past.

Study 3 aimed to explore an important hypothesis that can be derived from this proposition. Specifically, we tested whether the mental accessibility of the goal-directed behaviour (or the ease of accessing the representation of the behaviour in memory) moderates the intention-behaviour relationship. Based on the auto-motive model of habitually performed goal-directed behaviours, we hypothesized that intentions do not predict later behaviour when the behaviour is highly accessible, while the behaviour will be guided by intentions when accessibility is low. To test this hypothesis, we measured intention to cycle as well as the mental accessibility of goal-directed cycling behaviour and investigated the interaction between these two measures in the prediction of future cycling behaviour. Accessibility was measured with a response latency task, modelled after Aarts and Dijksterhuis (2000a; see also Sheeran *et al.*, 2005), in which participants have to indicate as fast as possible if a presented transport mode is a realistic option to travel to a previously (and briefly) presented travel destinations: the faster the responses, the higher the accessibility of the mental representation of the goal-directed behaviour (in this case of cycling behaviour).

Method

Participants and design

Sixty-five students (56 females and 9 males) of the University Utrecht participated for € 5. Similar to the previous studies, the study consisted of a longitudinal design. The first measurement (assessing accessibility and intentions as to cycling behaviour to various

destinations in Utrecht) took place 4 weeks prior to the second measurement (in which the same cycling behaviours were measured).

Measurement one

The first measurement was conducted on a computer in separate cubicles and all the necessary instructions were provided on the screen. In this first stage, we measured the intentions to travel to six destinations by bicycle on a 9-point scale. In addition, we measured the accessibility of cycling behaviour to these six destinations. For this purpose, participants were told that they were going to be briefly exposed on the screen to travel destinations that were each time followed by a transport mode. They had to imagine going to the various destinations, thereby providing a context for travelling. Similar to Study 2, a pilot test revealed that our sample of students perceived the bicycle to be highly instrumental in reaching the various destinations. Participants were asked to indicate as fast as possible whether the presented transport mode was a realistic means of transport to them in order to reach the respective travel destination by pressing a 'yes' or a 'no' key on the keyboard. The task consisted of 50 destination-transport mode combinations that (also based on a pilot study) were divided into 25 realistic and 25 unrealistic combinations. This way, 25 destination-means combinations required a yes-response and 25 destination-means combinations required a no-response. Only six of the realistic combinations were the critical trials in which we assessed the accessibility of cycling behaviour. Prior to the 50 trials, three warming-up trials were presented. The 50 trials were presented randomly. Each combination trial started with a fixation cross in the middle of the screen (500 ms), after which a destination was presented (300 ms), a blank screen (150 ms), and finally a mode of transport. The means of transport remained on the screen until participants pressed a key. Response times were measured in ms. The inter-trial time was 1 second. The accessibility measure was operationalized as the speed of responding with 'yes' to the six critical location-bicycle combinations (98.1% of all responses, showing that our participants perceived the bicycle as an instrumental means to attain the travel goals). Extreme latencies (higher than three standard deviations above the mean) were excluded from this measure. Finally, participants' e-mail address and phone numbers were collected to contact them for the second measurement.

Measurement two

The second measurement was conducted 4 weeks after the first measurement. Participants were asked to indicate the frequency of their bicycle behaviour to the various locations in the past 4 weeks by typing in the number of times they performed the behaviour. Finally, some demographics were again collected to link the results from the first measurement with those from the second measurement.

Results and discussion

As cycling behaviour to several different destinations was measured, we calculated Cronbach's alphas for the measures of intention, mental accessibility, and future behaviour. All alphas were larger than .70, indicating satisfactory internal consistency across destinations. Subsequently, we calculated a mean score for each of the three measures.

A hierarchical regression analysis was conducted for which all independent variables were zero centred for later behaviour; intention and accessibility were entered in Step 1, and the interaction of intention by accessibility was entered in Step 2. The correlations between the variables are presented in Table 3a. The results (presented in Table 3b) show that intention was positively related to later behaviour. More important, the interaction between intentions to cycle and accessibility of the mental representations of cycling approached significance, $b = 0.25$, $p = .06$.

Table 3a. Correlations between cycling behaviour 4 weeks later from accessibility and intentions ($N = 65$)

	Future behaviour	Intentions	Accessibility
Future behaviour	–	.29*	.00
Intentions		–	.09
Accessibility			–

Note. * $p < .05$.

Table 3b. Hierarchical regression analysis predicting cycling behaviour 4 weeks later from intentions to perform the behaviour and accessibility of cycling behaviour to various locations ($N = 65$)

Variable	β	t	p
Intentions	0.29	2.36	.022
Accessibility	–0.024	–0.20	ns
Intentions \times accessibility	0.25	1.87	.066

To gain further insight in this interaction and to test our specific hypothesis, we conducted simple regression analyses by calculating simple slopes for intention at varying levels of accessibility (in accordance with Study 1 and 2). To identify the levels of accessibility and intention to use in the simple regressions, we estimated scores one standard deviation above the mean and one standard deviation below the mean. This allowed us to test the relation between intention to cycle and actual cycling behaviour for high and low accessibility of the mental representations of cycling. Figure 3 presents the regression lines for the interaction effect of intention by accessibility on later behaviour. Simple slope analyses showed that intention was positive related to later behaviour when accessibility was low, $b = 0.67$, $p = .006$, but was not related when accessibility was high, $b = 0.00$, *ns*. Hence, in support of our hypothesis, intention was predictive of later behaviour when the mental accessibility of the behaviour was low, while the behaviour was not related to intention when the accessibility was high.

GENERAL DISCUSSION

Building on previous work on the role of habits in goal-directed behaviour, the present research proposed and tested that behaviour is controlled less by intentions when habit increases in strength. Previous research has considered frequency of past behaviour to be an important proxy of habits and, hence, has shown that measures of past behaviour

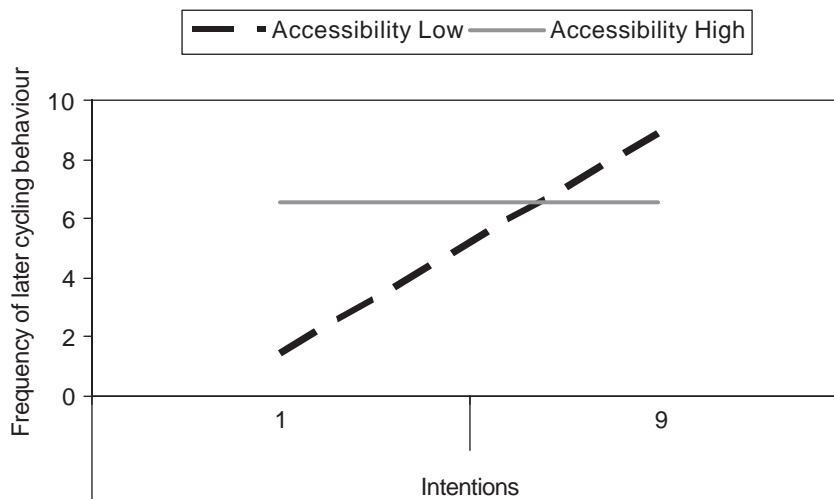


Figure 3. Decomposition of two-way interaction: frequency of cycling behaviour over 4 weeks as a function of intentions to perform the behaviour and accessibility of cycling behaviour to various locations.

frequency predict future behaviour over and above intentions. The findings of the present studies indicate that frequency of past behaviour does not necessarily result in habitually driven behaviour. Specifically, we demonstrated that frequency of past behaviour moderated the intention-behaviour relations only when information about the stability of the context in which the behaviour has been performed is represented in a habit measure: intentions do not guide behaviour when it is frequently performed in a stable context (i.e. strong habit), while intentions are more likely to guide behaviour under conditions of either infrequent performance or unstable variable contexts (i.e. in both cases there is a relatively weak habit).

These findings are important as they show that the context in which the behaviour is performed plays a crucial role in the establishment of habits: behaviour can be performed very frequently in a given time-span, but as long as the context – that is, place, time, and situation – in which the behaviour is executed always differs instigation of the behaviour is dependent on intentions. Similarly, although behaviour is always performed in the same context, intentional processes will still guide behaviour when performance of the behaviour only occurs occasionally (e.g. annually or bi-annually, see Ouellette & Wood, 1998). In both cases, people seem to be more prone to rely on their conscious thought and intent to produce the behaviour. Moreover, our studies extend previous work that addresses (either implicitly or explicitly) the importance of the context of behaviour in understanding the role of habits in intention-behaviour relationships (Aarts *et al.*, 1998; Ouellette & Wood, 1998; Verplanken *et al.*, 1998; Wood *et al.* 2005).

It should be noted, however, that our studies are correlational in nature and rather unspecific in the parametric functions that frequency and stability serve in the habitual control of behaviour. Thus, it may be fruitful to examine in future research how frequency and stability cause people to shift from intentional to habitual modes of goal-directed action. Another issue that should be taken into account concerns the measurement of context stability. In the present study, the context is considered stable

when location, time, and situation in which the behaviour is executed are always similar. Therefore, these three factors are all important aspects of the context stability measure. However, stability of the context in the present research was assessed with a single-item measure. Although this single-item measure yielded consistent results across the different behaviours in Study 1 and Study 2 (showing the importance of context stability), future research might improve the context stability measure by assessing the three aspects (i.e. location, time, and situation) separately.

In addition, Study 3 explored the idea that goal-directed behaviour is no longer guided by intentions when the representation of the behaviour can be easily accessed in memory. In this study, participants were asked to indicate as fast as possible whether bicycle was a realistic option to reach travel destinations (cf. the Response Frequency measure proposed by Aarts *et al.*, 1998; Verplanken *et al.*, 1998). Results showed that this accessibility measure interacted with intention in the prediction of future transport mode behaviour. Actual bicycle behaviour was not predicted by intentions to use the bicycle for participants who readily accessed representations of bicycle use in memory. However, intentions predicted behaviour for participants who less readily accessed these representations, indicating that people are more likely to form and act on explicit intentions when the mental representation of the behaviour is less accessible. These findings support the idea that goal-directed behaviour can be directly instigated by the context at hand when the mental representation is readily accessed as a result of frequent and consistent performance of the behaviour in the same context. In another recent line of research, Danner, Aarts, and De Vries (2007) showed that the mental accessibility of goal-directed behaviour is related to the habit scale used in the present studies. Thus, whereas the present studies do not directly test the mediational role of accessibility of representations of goal-directed behaviour, our findings suggest that habitual behaviour is triggered in the presence of a stable context without the mediation of intentions because people directly access and act on the behaviour representation to guide their behaviour.

Furthermore, the present research addresses to recent work on automatic goal pursuit (Bargh, 1990; Custers & Aarts, 2005; Kruglanski *et al.*, 2002; Moskowitz *et al.*, 2004). This research assumes that goal-directed behaviour is represented in knowledge structures including the context, the goal, and means that may aid goal pursuit. These associative networks are shaped by one's history. As the mental representations of the context, goal, and respective goal-directed actions are assumed to be strongly interconnected, perception of the context may directly activate the representation of the related goal and the connected goal-directed actions. The present findings provide correlational evidence for this notion. That is, we demonstrated that goal-directed behaviour (in this case, transport mode behaviour) is not predicted by the intention to perform the behaviour when the representation of the behaviour (or goal-means link) is readily activated by the behavioural (travel) context at hand. Given the present evidence of the role of mental accessibility of representations of goal-directed behaviour in predicting habitually driven behaviour, it would be important to further study and understand the activation mechanisms in the goal-means network as a function of parameters (such as frequency and stability) that characterize habitual goal-directed behaviours (Aarts & Dijksterhuis, 2000a; Danner, Aarts, & De Vries, *in press*).

The present research may also add to the debate about how habits should be operationalized in research on attitude-behaviour models. Several different operationalizations are proposed in the literature, e.g. the Response Frequency measure (e.g. Aarts *et al.*, 1997) and the Self-report Habit Index (Verplanken & Orbell, 2003). Some researchers

developed measures of habits that rely on subjective introspection of the processes underlying habits, such as assessing the extent to which one performs a given behaviour 'by force of habit' (Wittenbraker, Gibbs, & Kahle, 1983) or 'without awareness' (Mittal, 1988). Although one may question the validity and reliability of introspective reports on psychological processes accompanying habits, especially since processes underlying habitual behaviour operate unconsciously (Nisbett & Wilson, 1977; see also Verplanken & Aarts, 1999), these measures attempt to tap into unique aspects of habits (cf. Verplanken, Myrbakk, & Rudi, 2005). For example, the Self-Report Habit Index assesses a number of components that characterize the automatic nature of habits, such as some of the distinct features of automaticity (Bargh, 1994). The present study may add a new aspect to the measurement of habits, namely mental accessibility of goal-directed behaviour. Specifically, our findings indicate that the more easy one can access the mental representation of behaviour in memory, the less likely the behaviour is guided by conscious intent. Therefore, assessing the mental accessibility of goal-directed behaviour may provide additional information about the extent to which the behaviour has gained in habit strength that otherwise may go unnoticed due to people's inability and/or unwillingness to introspectively report on their habits (cf. De Houwer, 2006; Fazio & Olson, 2003).

Clearly, following the behaviourist tradition (e.g. Hull, 1943; Skinner, 1953), frequency of past behaviour is the most recognized method but, as the present data show, such a measure may not tap the actual essence of habitual goal-directed behaviour (Ajzen, 2002; Mittal, 1988; Verplanken *et al.*, 2005; Wood *et al.* 2005). As Mittal stated: 'Repeated occurrence is necessary for the formation of habit, but is not habit itself' (p. 997). The present study suggests that, in line with Wood *et al.*, a measure of habit should incorporate information about (self-reported) frequency as well as stability of the context of behaviour. Specifically, future behaviour is less predicted by intentions to the extent that people perform the behaviour frequently in the same context. We, therefore, believe that the present studies may provide a useful and challenging analysis to research that focuses on the role of habitual and intentional control of goal-directed behaviour.

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