By Force of Habit

On the Formation and Maintenance of

Goal-Directed Habits

Unna Danner

This research was funded by ZonMW, the Netherlands organization for health research and development, Grant 40160001

Photography: Bas Hattink
Cover design: Myrke Nieweg and Yrja Danner
Printed by Ridderprint Offsetdrukkerij B.V., Ridderkerk, The Netherlands
ISBN/EAN: 978-90-5335-134-5

By Force of Habit:
On the Formation and Maintenance of Goal-Directed Habits

Uit Macht der Gewoonte:

Het Vormen en In Stand Houden van Doelgerichte Gewoontes

(met een samenvatting in het Nederlands)

Proefschrift

ter verkrijging van de graad van doctor aan de Universiteit Utrecht op gezag van de rector magnificus, prof.dr. J.C. Stoof, ingevolge het besluit van het college voor promoties in het openbaar te verdedigen op vrijdag 2 november 2007 des middags te 12.45 uur

door

Unna Nora Danner

geboren op 19 november 1977 te Amsterdam

Promotoren: Prof. dr. H. Aarts

Prof. dr. N.K. de Vries

Index

Chapter 1: General introduction 5

Chapter 2: Habit formation and multiple means to goal attainment 23

Study 2.1 30
Study 2.2 38
Study 2.3 41

Chapter 3: Strong habit intrusion in goal-directed behavior 53

Study 3.1 59
Study 3.2 62

Chapter 4: Habit versus intention in the prediction of future behavior ... 73

Study 4.1 79
Study 4.2 87
Study 4.3 92

Chapter 5: General discussion 103

References 119

Summary 135

Nederlandse Samenvatting 139

Dankwoord 143

Curriculum Vitae 145

Chapter 1

General introduction

The aim of this thesis is to examine how goal-directed habits are formed and established. Specifically, I will analyze the cognitive mechanism underlying habits and the role of intentions in guiding goal-directed behavior. In studying the cognitive mechanism, I will demonstrate the possible functional role of inhibition in two separate ways. Inhibitory processes (1) facilitate the formation of habits in a context where several means are available for goal attainment and (2) ward off habitual intrusions when intentions are formed to perform non-habitual behavior. Furthermore, as habitual behaviors are often conceived of as becoming dissociated from conscious intentions to perform the behavior, I will provide evidence that habits moderate the relation between intentions and later goal-directed behavior.

In daily life we perform all kinds of behaviors to attain specific goals in absence of conscious awareness as we have performed these behaviors many times before. To take an example, in the morning I may grab my belongings and walk towards my bicycle to take my standard route to work, all without (much) conscious thought as I have carried out these behaviors on many previous occasions. Or, I may enter my favorite pub on Friday night to meet my friends who are already sitting at the bar. After saying hello to them I automatically ask the bartender to pour a pint of beer for each of us, although each Friday night while standing at that same bar I declare that I actually would prefer a glass of wine (in my opinion it tastes better and will cause less of a hangover the next morning, especially after having fish for dinner). It may even be after a couple of beers that one of my friends asks me why I am not drinking wine before it hits me that I have not thought of this option; I failed once again to act upon my genuine intentions. After all, I always order beer when meeting my friends in this pub.

People are thus able to perform rather complex behaviors (e.g., getting to work, socializing with friends) in the absence of explicit intent as a result of frequently engaging in them. It is even more striking that people are capable of automatically selecting and performing a specific goal-directed behavior without

considering all possible options that may also serve as means to attain their goal. Although I could have ordered all kinds of drinks and actually prefer another drink, I ask for my usual beer. When reflecting on the reason why a specific action is undertaken, people often come up with the answer "because I always do so" or in other words, *by force of habit*.

However, to be able to perform goal-directed behavior in a habitual fashion, one must first form the habit. This formation process seems especially challenging in a situation where multiple means are available for goal attainment. Even though we can choose between different drinks to attain the goal, we select a specific means (beer) while the other means (wine) seem to be forgotten. But how does this process occur anyway? When goal-directed habits have developed, it seems also challenging to execute intentions to perform non-habitual behavior to attain the same goal. How do we manage to act upon these intentions without the habit hindering this process? Furthermore, once habits are established, under what circumstances can intentions be effective, and when is it less likely that intention will lead to action? These questions that are addressed in the present thesis seem to gain in interest in recent research on regulatory processes in cognitive social psychology.

There are different kind of habits, such as instinctive, reflexive behaviors (e.g., stuttering) or learned simple behavioral reactions to environmental cues (these behaviors are a central topic in behaviorism). Therefore different conceptualizations of habits exist. In this thesis, I discuss research on habits as goal-oriented – that is, as a form of automatic goal-directed behavior, e.g., socializing with your friends each Friday night in the same pub by means of sharing a beer or two. I will focus on the understanding of goal-directed habits, both on the formation and on the maintenance of these habits. The remaining part of this introductory chapter I will briefly provide an overview of the main theoretical issues and assumptions that underlie my research. I will first discuss theory and research that conceptualizes habits as knowledge structures. Specifically, I will argue that habits can be regarded as goal-means associations

that gain in strength due to practice. Subsequently, the potential relevance of inhibitory control in the formation of habits will be discussed. That is, I will argue that habit formation has to be shielded against the interference of other means that are also available for attainment of the same goal. Then I will focus on the mental processes guiding intentions to deviate from habitual behavior and examine the role of intentions in controlling and guiding habits. Specifically, I will discuss how habits moderate the relation between intentions and future behavior. In the final part of this introduction, I will introduce the three chapters in which the mental processes underlying habits are empirically tested. Before I elaborate on these issues, I will first outline a brief history on the conceptualization and examination of habits in human behavior.

A historical note on habits

The appreciation of habits as important elements of everyday life has a long history in psychology and was already apparent in William James's Principles of Psychology (1890). James dedicated an entire chapter to habits and he argued in the first sentence of this chapter that one has to acknowledge "living creatures as bundles of habits". Although his description of habits pertains to various kinds of behavioral habits, his explanation of their purpose and shaping through practice does also apply to goal-directed habits:

> "As Dr. Maudsley (1876) says: If an act became no easier after being done several times, if the careful direction of consciousness were necessary to its accomplishment on each occasion, it is evident that the whole activity of a lifetime might be confined to one or two deeds – that no progress could take place in development" (p. 114).

In line with these ideas behaviorists postulated that behavior is largely influenced by habits (e.g., Hull, 1943; Skinner, 1938; Watson, 1914). As they conceptualized habits as well-learned simple stimulus-response associations, they reduced human behavior to merely rigid behavioral patterns that automatically follow environmental cues.

Albeit habits were more than a century ago considered to be a crucial element of human functioning, they did not always have a central position in social scientific theorizing and research. The interest even seemed to diminish together with the behaviorist tradition when the cognitive revolution was initiated. However, a few decades ago a revival of interest became visible in the context of attitude-behavior models. For a long time social psychology has modeled behaviors as to be controlled by intentional processes (e.g., Dewey, 1929; Lewin, 1935; see also Geen, 1995). This idea of intentionality has been incorporated in more recent models of goal-directed behavior as, for example, proposed in the theory of planned behavior (Ajzen, 1991), in the social learning theory (Bandura, 1977) and in the self-determination theory (Deci & Ryan, 1985). Whereas these models share the common believe that goal-directed behavior is initiated by conscious intent, it is only recently that research shows that these goal-directed behaviors can emerge in a nonintentional automatic way (e.g., Aarts & Dijksterhuis, 2000a; Bargh, 1990a; Wegner & Bargh, 1998). Even though much has changed since the behaviorist's perspective on behavior, some of their key assumptions concerning habitual behavior can still be found in contemporary theories on habits (Aarts & Dijksterhuis, 2000a; Betsch, Haberstroh, & Höhle, 2002; Cooper & Shallice, 2000; Ouellette & Wood, 1998; Sutton, 1994; Verplanken, Myrbakk, & Rudi, 2005).

One of the main assumptions in behaviorism was the idea that habits emerge as a result of the repeated performance of behavior. In other words, the frequency of past behavior is a good predictor of later behavior, e.g. the more often one has a sandwich for lunch, the more likely it is that one will have a sandwich for next lunch. The role of past behavior has been subject to investigation in the context of intention-behavior models (e.g., Ajzen, 1991; Fishbein & Ajzen, 1975). These models, however, were based on the idea that intentions are the guiding force underlying behavior and thereby ignored the possible direct impact of past behavior on future behavior. In the context of these models, some researchers have argued that not all behavior is likely to be guided by these deliberate processes (e.g., Aarts, Verplanken, & Van

Knippenberg, 1998; Ouellette & Wood, 1998; Ronis, Yates, & Kirscht, 1989; Wood, Tam, & Querrero Witt, 2005). A number of studies have been conducted since then that show a direct relation between past and future behavior. One of the first studies on this topic (Bentler & Speckart, 1979) showed that participants' past usage, and not only their intentions, of alcohol, marijuana and hard drugs was directly related to their later consumption of these substances. Thus, repetition of behavior renders it more likely to become habitual.

Besides the repetitive nature of habitual behavior, James also emphasized another important aspect: "…habit diminishes the conscious attention with which our acts are performed" (p. 116). Behaviorists argued that the stimulus is capable of directly triggering the habitual response once a stimulus-response combination is learned, but they were not interested in the mental processes that possibly mediate this effect. Research in the area of neuro- and cognitive psychology extended beyond this stimulus-response connection by focusing on more neuropsychological processes (e.g., Balleine & Dickinson, 1998; Botvinick & Plaut, 2006). According to their view, the brain consists of a habit system and a separate goal-directed (intentional) system. Habits, in line with the behaviorists' perspective, consist of action representations that are directly triggered by environmental cues, while goal-directed behaviors are the result of more intentional processes. According to this view, goal-directedness is equivalent to intentionality and hence, intentions always underlie the instigation of behavior to attain specific goals.

How, then, can habits be regarded as a form of automatic goal-directed behavior? In contrast to the neuropsychological perspective, intentions and goals have been argued to be distinct concepts (see also Bargh, 1990b). Evidence for this distinction stems from research on automatic goal pursuit (e.g., Aarts, 2007; Bargh, 1990a; Bargh & Gollwitzer, 1994; Moskowitz, Li, & Kirk, 2004; Shah, 2003; Sheeran et al., 2005). Findings in this domain provided more insight in the 'little black (cognitive) box' between environmental cues and the associated behavioral response by showing that goal-directed behavior is not necessarily guided by conscious intentions: goal attainment can be

accomplished without awareness of the mental processes underlying the instigation and execution of the behavior. Thus, whereas intention may play a role in the formation of goal-directed habits, with sufficient practice the instigation of goal-directed behavior does no longer have to rely on intentional control. This notion is congruent with the findings that past behavior can have a direct relation with and impact on future behavior. Therefore habits can be viewed as a specific form of automatic goal-directed behavior.

Researchers have thus started to go beyond the rather simple past-future behavior relation (Verplanken & Aarts, 1999) to comprehend and examine the mental processes underlying the nonconscious performance of behavior to attain specific goals and the automatic initiation of these behaviors automatically when confronted with the appropriate situation (e.g., Aarts & Dijksterhuis, 2000a, 2000b; Norman & Shallice, 1986; Wegner & Bargh, 1998). These insights are not only important to understand *when* the behavior can be instigated automatically, but also to understand *how* this process evolves and can emerge. In the present thesis I therefore focus on (1) the formation of habits when confronted with several different means for goal attainment, (2) the way intentions to behave in a non-habitual manner are shielded against habitual intrusion and (3) when habits and not intentions control later behavior in the context at hand. To provide a background as to the mental processes involved in goal-directed habits, I will now elaborate on recent research that consider habits as knowledge structures of behavior.

Habits as knowledge structures

As discussed above, there is ample evidence nowadays that, when confronted with the appropriate situational cues, people are indeed capable of engaging automatically in goal-directed behavior, i.e. without being conscious aware of activation and pursuit of the goal (e.g., Moskowitz et al., 2004; Wegner & Bargh, 1998). It is assumed that habits, as a specific form of automatic goal-directed behavior, are mentally represented as strong associations between the goal and the means instrumental for attainment of

the goal (Aarts & Dijksterhuis, 2000a, 2000b; Bargh, 1990a), e.g. drinking beer with one's friends as a means to socialize. The strength of the habit is determined by the frequency of performing the behavior to realize the goal and habits are therefore shaped by one's personal history (Aarts, 2007). That is, the strength of the idiosyncratic goal-means association is dependent on the repeated co-occurrence of the goal and means in the past. Eventually, activation of the goal will automatically trigger the mental representation of the behavior.

However, goal attainment can often be realized using different unique means, also called the principle of equifinality (Kruglanski et al., 2002). According to the goal system theory of Kruglanski and colleagues, one important aspect of goals and the means to attain them is that they are all part of a cognitive network that consists of facilitative connections. Through these connections, activation of the goal will spread to the associated means (J. R. Anderson, 1993; Mäntylä, 1993). As a result, all available means are activated and will therefore become accessible upon activation of the goal. However, it is impossible to use all these different means to attain the same goal and consequently a specific means has to be selected. Through intentional control, one can reflect on all the possibilities and potential consequences and decide on a choice of means (e.g., Nejad, Wertheim, & Greenwood, 2004; Shim & Maggs, 2005). For example, when gathering for the first time with one's new friends in a pub, one is likely to ponder over the possible drinks that one can order, e.g. "what kind of drinks are available", "what are my friends drinking", or "did I have fish for dinner", before one decides to order a beer.

When more evenings are spent in the pub though and one always orders beer, it would not be useful to contemplate each time over one's choice of beverage. Fortunately, repeatedly selecting and using the same means for the same goal, will reduce the need to exert intentional processes for goal pursuit (Aarts et al., 1998; Bargh, 1990a), e.g. the more often one orders beer when socializing with friend in the pub, the more likely it is that one will select a pint again. Next instigation of the goal on subsequent occasions (i.e., once a specific

means has been selected and used for goal attainment) increases the probability of retrieving the means from memory that was previously selected (J. R. Anderson, 1983; Betsch et al., 2002). It is therefore likely that the goal will be pursued with the same means.

Aarts & Dijksterhuis (2000a) were among the first to directly investigate the idea that behavior aimed to attain a goal will be activated more quickly by that goal when the goal-directed behavior has been executed repeatedly in the past. They tested their ideas in the realm of travel behavior, because this type of behavior is prone to be performed in a routine manner. The travel behavior consisted of students' cycling habits to different locations in town. Mental activation of the means was assessed by measuring participants' response latencies to words related to cycling (i.e., the means) upon priming with the travel locations (i.e., the goal). The results demonstrated that priming of the goal to travel to these locations facilitated access to the means "bicycle" but only for those participants who regularly used the bicycle to get to these locations. Sheeran and colleagues (2005) replicated these findings in the domain of drinking behavior by demonstrating that habitual drinkers were more inclined to drink alcohol after priming the goal of socializing than non-habitual drinkers.

So after having chosen a specific means for goal attainment, there is a kind of "cognitive preference" to retrieve and select this means again for future pursuit of the same goal. However, it does not necessarily imply that other alternative means, also available for goal pursuit, are no longer options, that is, they are no longer associated with the goal. When the associative strength of these means is sufficient, they will also be activated upon goal activation and might cause interference with the retrieval of the cognitively preferred means (Shah, Friedman, & Kruglanski, 2002), e.g. it will be difficult to quickly order a sandwich for lunch without considering salad, pancakes or other food when these options keep intruding one's conscious thoughts. These alternatives form a potential threat to accomplish the goal in an efficient manner as they may interfere with the retrieval speed and likelihood of the previously selected

means (Gollwitzer, 1990; Norman & Shallice, 1986). Whereas this notion of interference of means during retrieval of target means may sound common sense, research on goal-directed habits has heretofore only devoted little theoretical and empirical attention to it. In the next section, I will discuss how people deal with this interference to ease the formation of goal-directed habits.

Forming habits: The role of inhibition

To start the process of habit formation in a context where several means are available for goal attainment, one has to take two cognitive aspects into account: first to retrieve the target means from memory and second to reduce interference caused by alternative means for the same goal. Through the inhibition of these alternatives, it is easier and more likely that the target means will be found and retrieved from memory. Hence, inhibitory control may be crucial to instigate habit formation by reducing the activation of the alternative means before they reach conscious thought (Blackmore, 2003; Levy & Anderson, 2002). For example, to create a habit to have a sandwich for lunch, alternative lunch possibilities (salad, pancakes) will be inhibited upon activation of the goal to have lunch in order to increase the likelihood to have a sandwich. So how does the process evolve in which one first intentionally chooses between the available means, whereas repeated use of the same means establishes a situation in which mere activation of the goal results in facilitated access to that means and inhibited access to alternative means? How does one get rid of thoughts about salad and pancakes?

To gain insight in this process, it is necessary to reconsider the knowledge networks in which goals and the means to attain them are embedded. These networks are assumed to be hierarchically ordered and not only to consist of facilitative connections but also to consist of inhibitory connections (Cooper & Shallice, 2000; Kruglanski et al., 2002). It is likely that top-down processes guide goal-directed behavior: activation of the goal will trigger access to the associated means. The inhibitory connections are assumed to be lateral connections - i.e., between either different goals or different means - that have

to be learned or created in memory. To promote the formation of habits, inhibitory connections between the competing means are established upon the first realization of the goal. Inhibitory processes of means in goal pursuit are therefore learned (Shah et al., 2002) and as a result of this inhibition, searching and retrieving the previously selected means can occur more efficiently as it will not be hindered by interfering means.

One of the most compelling lines of research providing evidence for such a process stems from research on memory retrieval and forgetting (M. C. Anderson & Spellman, 1995). Anderson and colleagues created a paradigm that they referred to as the Retrieval-Induced Forgetting paradigm, to examine how retrieving some items (e.g. banana and strawberry) within a specific category (e.g., fruit) influences the accessibility of other items (e.g., apple and orange) within that same category. The paradigm consists of three distinct phases: a study phase to ensure that the items are equal members of the same category, a retrieval phase to stimulate memory retrieval with a cued stem completion task (e.g., fruit – ba___), and finally a cued recall task to measure the likelihood of recalling the retrieved and nonretrieved items from memory. The results are compared to a baseline consisting of items from a different category (e.g., furniture) that are also studied but are not retrieved and therefore do not require inhibitory control. It was found that retrieval of some items from a category (banana and strawberry) impaired recall of other items (apple and orange) from that same category indicating that those items were inhibited. Many others in various domains have replicated these inhibitory effects. These effects are even established with accessibility measures that do not rely on the cued recall task to assess a reduction in the activation level (i.e., inhibition) such as a verification task and an item recognition task (e.g., Perfect, Moulin, Conway, & Perry, 2002; Veling & Van Knippenberg, 2004; see M.C. Anderson, 2003, for an overview).

Inhibition has been found to regulate different types of memory processes pertaining to different aspects of human functioning (e.g., selective attention, Tipper, 2001; social stereotyping, Macrae, Bodenhausen, & Milne, 1995). In

general, inhibition enables people to override prepotent memories by preventing these from entering awareness (M. C. Anderson & Green, 2001; Dagenbach & Carr, 1994; Radvansky, 1999). That is, the activation of these memories is reduced to avert interference with ongoing memory processes, such as the memory search and subsequent retrieval of a previously used means for goal attainment. Inhibiting interfering items or thoughts before they enter consciousness increases the clarity and speed of recognizing and acting on the target items. For instance, when being asked how one wants to get to work, it is easier to explain a specific route when access to the memory of other routes is inhibited. This type of inhibition is therefore assumed to occur implicitly (Dijksterhuis & Van Knippenberg, 1998; Levy & Anderson, 2002). That is, inhibitory control of interfering information that otherwise hinders current memory processes occurs without explicit intent to put the alternative means out of mind.

The role of inhibition has only very recently been investigated in the domain of goal-directed behavior (Kruglanski et al., 2002; Mayr, 2002; Shah et al., 2002). It is assumed that distracting goal-related information, such as alternative means for goal attainment, is inhibited in order to ease the instigation and pursuit of the goal. In a study using a task-switch paradigm, it was found that action rules were inhibited as a function of their accessibility (Mayr, 2002): action rules that are recently used but no longer valid are inhibited, whereas action rules used less recently are not inhibited. Furthermore, inhibition has been found to shield goal pursuit by reducing access to the mental representation of alternative goals (Shah et al., 2002). Shah and colleagues argued that inhibition of alternative goals has to be learned. Although their findings support the assumption that inhibition will also play a role in the formation of habits when confronted with multiple means, Shah and colleagues only examined this goal shielding effect in a situation where goals already were regularly pursued. It has not yet been examined if inhibitory control underlies the instigation of habit formation in the sense that alternatives for goal attainment are inhibited and if so, if these inhibitory

connections have to be created between the competing means, i.e. whether inhibition has to be learned.

To reiterate, inhibition of alternatives is proposed to play a role during the formation of goal-directed habits, because they are expected to interfere with the selection process (due to their association with the goal). However, interference is also likely to occur if one wants to change habits: in that case, interference with the intentions to use alternatives (i.e., non-habitual means) arises from associated habitual means. These intentions to perform non-habitual behavior to attain the goal are likely to be hampered by habitual intrusions. For example, although one intends to cycle to work tomorrow, thoughts of taking the bus to get to work (habitual behavior) intrude one's conscious thoughts. I will now discuss how the intentions to use alternatives may be shielded against this interference.

Shielding intentions from habits

People can either form intentions to act according to their habits or they can form intentions to pursue the (habitual) goal with a non-habitual means. Intentions to perform habitual behavior are likely to result in actual behavior as the habit is automatically triggered when encountering the context (behavior may not be controlled by conscious intentions, as I will address later on). It might be more difficult though to execute counter-habitual intentions because there is already a habit to attain the goal in a specific manner. Maintaining these intentions in memory is likely to suffer from interference by the habit, because the goal will facilitate access to the habitual means (e.g., Hay & Jacoby, 1996; Heckhausen & Beckmann, 1990). It seems therefore challenging to remember and implement the intention to engage in non-habitual behavior. The question that consequently arises is which process can prevent the habit from interfering?

Research on human error and action slips has shown that intentions to use non-habitual means for goal pursuit can be hampered by one's habits (e.g., Gollwitzer & Moskowitz, 1996; Hay & Jacoby, 1996; Norman, 1981; Reason,

1979), e.g. yet again one takes the bus to work, despite one's intentions to use the bicycle. Hence, to ensure the execution of intentions to use non-habitual means for goal pursuit, memory for these intentions has to be shielded against habitual interference. Inhibition can prevent this hindrance by reducing access to the habitual means upon their activation by the goal (Gollwitzer & Moskowitz, 1996; Norman & Shallice, 1986). However, research on the role of inhibitory control in guiding these processes is fairly limited. Knowledge of these processes can at one hand help to understand why it is difficult to deviate from one's habit and at the other hand help to understand how intentions to perform non-habitual behavior to attain goals can successfully be implemented (e.g., Holland, Aarts, & Langendam, 2006; Verplanken & Wood, 2006; Wood et al., 2005).

Many studies have been conducted on cognitive processes underlying the memory for the intention itself and for the information representing the content of the intention (e.g., Einstein & McDaniel, 2005; Goschke & Kuhl, 1993; Marsh, Hicks, & Bink, 1998). Although these studies focused mainly on the maintenance and execution of the intention, some researchers speculated that both facilitative and inhibitory processes are involved in memory for intentions (Freeman & Ellis, 2003; Goschke & Kuhl, 1993; Marsh et al., 1998): facilitation to have (the content of) the intention readily accessible in memory and inhibition to shield the intention against other interfering information. In a recent study, Veling and Van Knippenberg (2006) were among the first to investigate when interference occurs and how it is fended off. They investigated how the formation of an intention to act when presented with a specific cue, mentally influenced semantically related information in a subsequent task that required the implementation of the intention. Their results showed that intentions were shielded against distracting information that was (semantically) related to the content of the intention by inhibiting access to this information.

Although this research does not concern habits, it may have implications how counter-habitual intentions are shielded in memory. As it was found that irrelevant but associated information is inhibited, it can be expected that

habitual means are also inhibited because they are associated with the intention, irrelevant and most likely activated. Inhibition may thus seem to be the key to successfully execute one's good intentions: to take the bike to work, one just (implicitly) has to inhibit thoughts about using the bus.

Hitherto, I have discussed the formation and maintenance of habits, and intentions to perform non-habitual behavior to realize the goal. However, nothing is said about the predictive value of habits. In the next section, I will therefore focus on the prediction of behavior by habits and intentions.

Intentions, habits and behavior: the role of context stability

Despite different perspectives on habits, there is general agreement on the notion that environmental cues can trigger behavior directly without the involvement of intentional processes (e.g., Aarts & Dijksterhuis, 2000a, 2003; Botvinick & Plaut, 2006; Chartrand & Bargh, 1996; Neal, Wood, & Quinn, 2006). So the mental representation and subsequent instigation of behavior is automatically elicited in the presence of cues from the context in which the habit is formed (Aarts & Dijksterhuis, 2000a; Bargh, 1990a). An important assumption is therefore that behavior is controlled by habitual instead of intentional processes through the frequent performance of the same goal-directed behavior (i.e., using the same means for attainment of the same goal) in the same context over and again (Aarts et al., 1998; Ouellette & Wood, 1998; Wood et al., 2005).

Frequency of past behavior may thus not be the sole factor determining habit strength as the behavior also have to be performed in a stable context, e.g., whether one will drink beer in the pub does not only depend on how often one has drunk beer before, but also on how often one did so in the same pub in the company of these same friends. There are three factors that render a context stable: past behavior has to occur always in the same location, at the same time and in the same situation. For example, one always drinks beer when socializing with one's friends (situation) in the pub (location) each Friday

night (time). Hence, when these factors are always consistent when the behavior is carried out, the context is stable (see also Wood et al., 2005).

For this reason, the stability of the context in which past behavior is executed can provide insight when behavior is best predicted by habits and when by intentions. Most studies on the role of habits in predicting future behavior, demonstrated that habits can predict behavior independent of intentions (e.g., Bentler & Speckart, 1979; Montano & Taplin, 1991; Ronis et al., 1989; see also Ouellette & Wood, 1998). This direct relation, though, between past and future behavior is not really informative as it tells us that we simply do the things as we did them before (Aarts, 2007). To develop a more sophisticated notion of the relation between habits and intentions, one should not only focus on both main effects but also understand the interplay between habits and intentions. This idea was already proposed by Triandis (1980): he suggested that because the same behavior is more frequently executed in the past and increases in habit strength, it is less guided by intentions to perform the behavior. Unfortunately most studies did not test or did not report such an interaction. One of the reasons is that only past behavior frequency was assessed as an indicator of habit strength (Verplanken & Aarts, 1999). There are a few studies that do report the interaction (Ferguson & Bibby, 2002; Montano & Taplin, 1991; Verplanken, Aarts, Van Knippenberg, & Moonen, 1998) but in these studies it is unclear how habits and intentions can be disentangled.

In a meta-analysis on this matter, Ouellette and Wood (1998) investigated the influence of past behavior and intentions on later behavior for two types of behavior: behaviors that are performed on a daily basis and most probably in a stable, predictable supporting context (providing an environment for habit development) and behaviors less frequently, annually or bi-annually, engaged in. Their findings demonstrated that past behavior repetition was only indicative of later behavior for those behaviors prone to be performed daily. In other work, Wood suggested that a habit strength measure should therefore consist of two combined components, i.e. past behavior frequency and context stability

(consistent location, time and situation, Wood et al., 2005). They found that this habit strength measure interacted with intention to perform the behavior: the behavior was no longer controlled by intention when performed repeatedly before in a stable context, whereas in the other instances (either low frequency of performing the behavior or in an unstable context) intention guided the behavior.

Although the results of Wood and colleagues are suggestive as to the role of context stability in goal-directed habits, I aimed to further examine this issue for two important reasons: first, to replicate these effects because they may add to the robustness for this idea that habits should be considered as behaviors that are performed both frequently and in a stable context, and, secondly, to investigate the relation between the habit index as proposed by Wood and colleagues, and a measure of past behavior frequency to figure out how context stability contributes to the habitual control of behavior.

The current research

In the current thesis I will describe several studies that aim to examine the role of inhibitory processes in guiding the formation of habits when several different means are available and to prevent established habits to interfere with having intentions in memory to use non-habitual behaviors for goal pursuit. Moreover, I will describe studies that investigate the moderating role of habits in the relation between intentions and later behavior by considering the stability of the context in which past behavior was performed. Below, I will provide a brief overview of the empirical chapters of this thesis. Please note in advance that the General Introduction and the empirical chapters may overlap to a certain extent. These chapters have been submitted to different scientific journals and each chapter can also be read independently from the rest of this thesis.

Chapter 2 describes three studies that aim to examine how habit formation can occur when there are multiple means to goal attainment. More specifically, with an adapted version of the Retrieval-Induced Forgetting paradigm (M. C.

Anderson & Spellman, 1995), I investigated the role of inhibition in the first stage of habit formation. The mental status of the means is afterwards determined by assessing accessibility with two distinct response latency measures: a goal-means verification task (Study 2.1) and a means-recognition task (Study 2.2 and 2.3). Moreover, to test whether the inhibitory effects occur implicitly rather than explicitly, in Study 2.3 I aimed to compare these inhibition effects as a function of explicitly suppressing the alternative means to ease the retrieval process versus no explicit suppression strategy.

Chapter 3 presents two studies to investigate how intentions to use non-habitual means for goal attainment are shielded against strong habit intrusions. In both studies, an idiosyncratic approach is used to gather habitual and non-habitual means for several different goals. Extending the idea that repeated performance of a specific goal-directed behavior will result in facilitated access to this means upon activation of the goal (Aarts & Dijksterhuis, 2000a), Study 3.1 will test whether the habitual means are more easily accessed upon activation of the goal than the non-habitual means and whether the differences in accessibility result from differences in frequency of past means selection. Study 3.2 aims to examine whether habitual means are inhibited to have intentions in memory to engage in non-habitual behavior.

Finally, Chapter 4 reports on three studies that investigate habit versus intention in the prediction of future behavior. In two correlational studies (Study 4.1 and Study 4.2) I examine how past behavior frequency and intentions interact in the prediction of future behavior when context stability of past behavior performance is taken into account. Study 4.3 explores the idea that if cues from the context are capable of facilitating access to the goal-directed behavior, mental accessibility of the behavior will similarly moderate the relation between intentions and later behavior.

Chapter 2

Habit formation and multiple means to goal attainment: Repeated retrieval of target means causes inhibited access to competitors

This chapter is based on Danner, U.N., Aarts, H., & De Vries, N.K. (2007). Habit formation and multiple means to goal attainment: Repeated retrieval of target means causes inhibited access to competitors. *Personality and Social Psychology Bulletin, 33*, 1367-1379.

Most human beings are fortunate to possess a mental system that allows them to find appropriate means in memory for attainment of their goals. Through practice and repetition, we are capable of swiftly initiating and performing our goal-directed behaviors in a routine fashion. Thus, when having dinner at one's favorite restaurant one may order ice cream instead of fruit salad for dessert without much conscious thought. Habit formation, then, allows us to readily retrieve and select a specific means from a set of different means in memory to pursue a specific goal.

The way people retrieve means from memory to attain goals in the course of forming habits is a fundamental concern in both basic and applied psychology (Betsch et al., 2002; Cooper & Shallice, 2000; Moskowitz et al., 2004). Most previous research on (habitual) goal pursuit has focused particularly on the retrieval and selection of a certain means for goal attainment (Aarts & Dijksterhuis, 2000a; Bargh, 1990a). More recently researchers have started to examine the role of *inhibitory* processes in goal pursuit (Mayr, 2002; Shah et al., 2002). Inhibition is argued to be a functional mechanism that reduces or prevents interference of accessible competing information and to "shield" current goal pursuit from distraction. However, less is known about inhibitory processes during the *formation* of goal-directed habits in a multiple-means context. Studying inhibitory processes as part of habit formation is crucial to understanding how people are able to choose between multiple means to pursuit their goal in a routine fashion without much attentional effort. It may lead to a better understanding how habits are established and in the end how they are maintained.

In the present chapter we investigate the cognitive process guiding the first stage of the habit formation process in a multiple means context. We assume that the inhibition of competing means eases the retrieval of target means and thus promotes the formation of goal-directed habits. Specifically, the retrieval and selection of target means upon goal instigation becomes more efficient when the associated competing means are inhibited before these competitors come to mind. Our purpose is to investigate some key assumptions derived

from this conceptualization. First, it is hypothesized that retrieval of a target means upon goal activation results in inhibited access to the competing means. Second, we assume that this inhibitory control requires some practice and can emerge implicitly, that is without conscious intent or explicit instructions to do so.

Goal-means network

For goal activation to have the desired effect, behavior representations need to be retrieved and accessed that represent appropriate means to attain the goal (Aarts & Dijksterhuis, 2000a; Austin & Vancouver, 1996; Wegner & Vallacher, 1986). Often goal attainment can be realized with the use of different mutually exclusive means, also called the principle of equifinality (Kruglanski et al., 2002); for example, bicycle and car may both be appropriate means for (and therefore associated with) the goal of traveling to work. According to the goal-system theory of Kruglanski and colleagues (2002), goals and their associated means are part of a knowledge network and this network consists of facilitative and inhibitory connections. There is some recent research that shows how goals and means are related to each other and how these relations affect the accessibility and selection of means for goals (Aarts & Dijksterhuis, 2000a; Kruglanski et al., 2002; Moskowitz et al., 2004).

According to the goal-system theory (Kruglanski et al., 2002), the connection between a goal and the associated means is facilitative but the connection between two means can also be inhibitory. The facilitative link between a goal and means indicates that activation of the goal facilitates access to the associated means, whereas the inhibitory link between the means suggests that the activation of one means inhibits access to the other competing means. This suggests that before a competing means is inhibited it is first activated by the instigation of the goal. Hence, inhibition is an active process between the means. For example, one may consider bicycle and car as two competing means for work travel (unless one can cycle and drive a car at the same time). In case one wants to take the bicycle to go to work, car use

interferes with the retrieval of the bike. Hence, the mental accessibility of the car may be inhibited when retrieving bike upon the activation of the goal of traveling to work.

There is some recent research showing the role of inhibitory processes in reducing or preventing interference of accessible competing behavioral information in the course of goal pursuit (Mayr, 2002; Shah et al., 2002). Shah and colleagues (2002) conducted research to examine inhibitory processes in the face of multiple competing goals. They asked participants to list several different goals (e.g., running, biking). Subsequently, accessibility of these goals was assessed under conditions of priming either one of these goals. Priming with one goal resulted in inhibited access to the other goal. They explained their results as a goal shielding effect that prevents competing goals from interfering. Shah et al. reasoned that the goals were part of a network in which they also served as subgoals to achieve an overarching goal (e.g., the goal of exercising). Priming one of the subgoals was assumed to activate the entire goal network. Consequently, the competing remaining subgoals were inhibited to shield the focal subgoal from distraction to attain the hypothesized overarching goal, as was concluded from the delayed response latencies on these subgoals. It is important to note, however, that they did not investigate this process directly. That is, inhibition of subgoals was not tested in the context and presence of the goal-means network under investigation.

The present research aimed to take a closer look at this issue. Specifically, we investigated the role of inhibitory processes during the initial stage of the formation of goal-directed habits. Accessibility of the competing means was therefore tested as a function of the frequency of retrieving target means for goals.

Inhibition and the formation of goal-directed habits

Habits have been known to play a pivotal role in human behavior. For instance, James (1890) considered habits to be extremely useful; they enable people to perform their actions in a mindless fashion, thereby creating more

room for doing things that necessarily require conscious processing. Furthermore, the concept of habit has been central in behaviorists' approaches to learning theories (e.g., Hull, 1943; Skinner, 1938; Watson, 1914). In this approach, habits are thought to be guided by well-learned stimulus-response combinations that are reinforced by positive rewards. Behavior, therefore, consists of habitual responses that are automatically initiated upon the presence of the environmental cues and as such are rigid behavioral patterns that do not need top-down-driven processes. The automatic and rigid nature of habits has remained a central assumption in several contemporary areas of research, such as social psychology (e.g., Bentler & Speckart, 1979; Neal et al., 2006; Ouellette & Wood, 1998) and (neuro)cognitive analyses of human as well as animal behavior (e.g., Balleine & Dickinson, 1998; Botvinick & Plaut, 2006). For instance, Ouellette and Wood (1998) showed that cognitive products of reasoning and conscious thought, such as intentions, do not predict behavior when the given behavior is well-practiced (see also, Aarts et al., 1998).

Building on recent work in the domain of social cognition and automatic goal pursuit (Aarts & Dijksterhuis, 2000a; Bargh, 1990a; Moskowitz et al., 2004), in the present chapter we examine the cognitive processes underlying the role of habits in goal-directed behavior. Specifically, we conceive of habits as being guided by mental representations of goal-means associations. According to this view, habit formation occurs when the same means is repeatedly and consistently retrieved for the same goal because it promotes an automatic search for and access to these means in memory (cf. J. R. Anderson, 1993; Mäntylä, 1993). Once a habit is formed, the instigation of the goal results in the immediate retrieval and selection of the associated habitual means. However, to form a habit and in the end to arrive at the automatic retrieval of the habitual means, one needs to avoid interference from distracting means that are also suitable for goal attainment (Cooper & Shallice, 2000; Kuhl & Beckmann, 1985; Shah et al., 2002).

Inhibition helps to avoid the interference by reducing the activation of the competing means before these means become accessible (for a broader

discussion on the functionality of inhibition processes see, e.g., Dagenbach & Carr, 1994; Dempster & Brainerd, 1995). That is, inhibitory control is necessary for memory retrieval to override prepotent memories or, more specifically, to prevent the mental representations of competing means for goal attainment to gain access to consciousness (M.C. Anderson, 2003; Moskowitz et al., 2004; Radvansky, 1999). Hence, inhibitory control is assumed to emerge implicitly, that is without conscious intent or explicit instructions to strategically suppress the competing information (Levy & Anderson, 2002; see also Dijksterhuis & Van Knippenberg, 1998; for a distinction between implicit inhibition and explicit suppression). In the context of habit formation in a multiple-means context, the inhibition of competing means for goal attainment is likely to require repetition because the inhibitory link between the means needs to be created in the memory system (Chan, Morell, Jarrard, & Davidson, 2001; Davidson, Kanoski, Walls, & Jarrard, 2005; Shah et al., 2002). How, then, may this practice process evolve during habit formation?

In line with others, we assume that the initial instigation of the goal will activate all associated means (e.g., Altmann & Trafton, 2002; Kruglanski et al., 2002), which enables people to select one of these means to attain the goal. Subsequent instigation of the goal increases the probability of retrieving the target means previously selected but, at the same time, activates the competing means that hinder the retrieval of the target means. A more efficient retrieval of this target means, then, is possible when the activated competing means are inhibited before these competitors gain access to consciousness. Accordingly, the potential interference of competing means can be resolved by establishing an inhibitory link in the memory system between the several means. This inhibitory link paves the road for practicing the inhibition of the competing means to promote the formation of goal-directed habits. According to this line of reasoning, inhibition of competitors is not likely to occur after a one-time retrieval of a target means but inhibition should show up upon subsequent retrieval of the target means for the goal. In other words, repeated

retrieval of a target means upon goal activation results in inhibited access to the competing means.

The present research

In a first attempt to investigate these ideas, three studies tested the inhibition of competing means as a function of repeated retrieval of a target means upon goal activation. To gain insight into the frequency component, we manipulated the number of times the target means had to be retrieved: one time, three times, or nine times. We expected inhibition to occur only after repeated retrieval, that is, after participants retrieved three or nine times the target means upon goal instigation. To test our prediction, we adapted the Retrieval-Induced Forgetting (RIF) paradigm developed by M. C. Anderson and colleagues (M. C. Anderson, Björk, & Björk, 1994; M. C. Anderson & Spellman, 1995). This paradigm is designed to examine the influence of memory retrieval of category items on other competitive items associated with the same category (see also M.C. Anderson, 2003, for an overview of research using the RIF paradigm in a variety of domains). We adjusted the RIF paradigm with the aim of investigating the influence of (repeatedly) retrieving certain means from memory upon goal activation on the accessibility of competitive means for the same goal. In line with the RIF paradigm, our experiments consisted of three distinct phases: a study phase, a retrieval phase and a test phase.

In the study phase, participants have to study several goal-means combinations (e.g., wanting to chat – computer and telephone, wanting a dessert – fruit salad and ice cream) to establish instrumental associations between the means and the specified goals and to create goal networks with two unique means strongly associated to one goal. In the retrieval phase, participants are asked to retrieve some of the given means to pursue some of the specified goals by using a cued-stem completion task (wanting to chat–co_). Because our main research question was how the process of repeated retrieval of target means for goal attainment influenced the accessibility of competing means, we experimentally varied the frequency of retrieving the

target means between participants: either one, three, or nine times. This phase thus simulates the retrieval and selection of target means upon goal activation. During the retrieval phase three distinct types of means are created: retrieved means (computer), nonretrieved means (telephone) for the same goal (wanting to chat), and nonretrieved baseline means (fruit salad, ice cream) for a different goal (having dessert).

The final phase of the experiment tests the accessibility of the different means. Inhibition of a mental concept is defined as a reduction in the activation level of that concept. In line with other research using the RIF paradigm, we assessed accessibility of the different means by using different reaction time tasks (see also Perfect et al., 2002; Veling & Van Knippenberg, 2004). Evidence for inhibited access to competing means, then, is established if the accessibility level of the nonretrieved means for the same goal is lower (responses to these concepts are slower) than the accessibility of the nonretrieved means for a different goal. The first two studies examined the inhibition of competing means as a function of repeated retrieval by assessing their mental accessibility in a goal-means verification task (Study 2.1) and a means recognition task (Study 2.2). A third study explored the idea that the inhibitory control occurs implicitly.

Study 2.1

In the first experiment a verification task was used in which participants were briefly presented with a goal (e.g., wanting to chat) and immediately asked to indicate whether a subsequent presented means (e.g., computer or telephone) is a means to pursue that goal. Responses on this task thus rely on the mental link between the means and the specified goal (Aarts & Dijksterhuis, 2000a). The rationale we followed here was that the stronger a nonretrieved competing means is inhibited as a function of previous retrieval of the target means upon goal activation, the slower the responses to verify that the nonretrieved competing means is a possible means for attainment of the goal (Perfect et al., 2002). To conclude that the access to the means is inhibited, however, a comparison has to be made with a proper baseline.

In a standard RIF experiment, the baseline means are not activated during the retrieval phase because participants are not exposed to the goals related to these means. As a consequence, the memory traces between these goals and their associated means will not render active. However, this may pose a problem to observe inhibition in the goal-means verification task (i.e., test phase). Both the retrieved target means and nonretrieved competing means will have an advantage in the verification task because of the recent activation of their memory trace with the goal in the retrieval task (the goal activates both means upon which the competing means is inhibited) in contrast to the baseline means. Activation of the goal in the subsequent verification task is more likely to activate the associated retrieved target means and nonretrieved competing means in comparison to the baseline means. Consequently, reaction times on the competing and baseline means may be equal because slower responses to the nonretrieved competitors because of inhibited access are elevated by the recent activation of their memory trace. Accordingly, one could incorrectly conclude that no inhibition occurred.

To control for this potential memory-trace advantage, another baseline condition was included in addition to the standard baseline condition. In this condition, half of the baseline goals were also presented in the retrieval phase, thus activating the memory trace between the baseline goals and their associated means (J. R. Anderson, 1983; Mäntylä, 1993). However, these means do not require retrieval (no cued-stem completion is required upon goal presentation) and therefore we call this condition the mere exposure baseline. Accordingly, these means should have the same memory-trace advantage in the verification task as the retrieved-target means and their nonretrieved competitors. Comparing the response latencies on the means from the retrieval condition with the means from the mere exposure baseline condition then is expected to provide a fairer test of facilitated access to the target (retrieved) means and inhibited access to competing (nonretrieved) means.

Method

Participants and design

One hundred and twenty-four Dutch undergraduates received €5 payment for their participation in the experiment. Participants were randomly assigned to one of the three retrieval-frequency conditions: one, three, or nine times.

Stimulus material

We selected 12 goals, each goal combined with two competing means, resulting in 24 different goal-means combinations. Each goal attribute represented a behavior (e.g., writing, relaxing) and each means represented an object (e.g., computer, television). The selection of the goal-means combinations was based on a pilot study that assessed the associative strength and perceived instrumentality of the goal-means combinations. Only goal-means combinations were selected that showed clear instrumentality but moderate association strength. This was done to ensure that their association could be strengthened in the study phase (see below), rendering the instrumental relations between the goal and means unique for the present experiment.

Procedure

Participants worked in separate cubicles on the experimental computer task. The computer provided all the instructions. Participants were told that the experiment consisted of several tasks that dealt with the pursuit of everyday goals by using all kinds of means. Therefore, participants were explicitly instructed to think in terms of the instrumental relation between goals and means (see also Shah et al., 2002). Next, participants worked on three consecutive tasks representing the phases of the RIF paradigm: the study phase, the retrieval phase and the test phase.

Study phase. The first phase of the experiment consisted of a task in which all the goal-means combinations were studied. Every combination was presented for 7 sec followed by a 1-sec pause. Participants were asked to carefully study the competing goal-means combinations and to consider each of

the two means sufficient to attain the goal. All the goal-means combinations were shown once. To make sure that two means associated to the same goal were not shown one after the other, two blocks were created. The first block consisted of the 12 goals connected to one of the means and the other block consisted of the same 12 goals connected to the other means. Before, between, and after the blocks, two filler goal-means combinations were used to prevent primacy and recency effects from occurring. The order of the blocks was counterbalanced between participants and within each block the goal-means combinations were chosen randomly.

Retrieval phase. After studying the goal-means combinations, participants were told that they would be shown some of the goals from the study task and that they had to imagine pursuing these goals using one of the means. On some trials the goal was presented together with one of the instrumental means they were supposed to use to attain the goal, and on other trials only goals were presented. To increase the feeling of means retrieval, it was told that on trials were the goal was presented with the means only the first two letters of that means would be displayed. Accordingly, participant's task was to complete each means by typing in the remaining letters. On each trial the goal was presented briefly (500 ms), followed by a pause (50 ms) and the presentation of the two letters of the means on some trials and on other trials not (these were the mere exposure baseline goals). The time to complete each means was limited to 5 sec and, when the correct answer was provided, the screen went black until the 5 sec passed, after which the next trial was displayed. Participants were told that if the answer was incorrect the goal and two letters of the means would be presented again until the answer was correct or the time ran out. In the *one-time retrieval practice condition*, six different goal-means letters combinations and three different exposure baseline goals were presented once. In the *three-times retrieval practice condition* this presentation procedure was repeated three times, and in the *nine-times retrieval practice condition* nine times.

To ensure that each means from the study phase would serve as a retrieved means, a nonretrieved competing means associated to the same goal and a baseline means (standard and mere exposure), different sets were created that varied the function of the means. These sets were counterbalanced between participants. Within every retrieval round, the presentation order of the goals and goal-means letters was random and presented once. Thus, after the retrieval phase, 4 different categories of means were created that each included 6 means: retrieved means, nonretrieved competing means associated to the same goal, baseline means of which only goals were presented (mere exposure) and baseline means of which nothing was shown (standard).

Test phase. In the final phase of the experiment, participants had to perform the goal-means verification task. The task consisted of 48 goal-object combination trials. Each trial started with a fixation cross appearing in the middle of the screen (500 ms), after which the goal word was presented (200 ms), a pause (100 ms), and finally followed by an object. Participants had to indicate as fast as possible whether the object represented a means instrumental for attaining the goal by pressing a "yes" or "no" key on the keyboard. The object remained on the screen until participants pressed a key. Response times were measured in ms. The intertrial time was 1 sec. The 48 trials consisted of the 24 goal-means combinations from the study phase, and 24 new goal-means combinations for which the means was not instrumental for attaining the goal (e.g., wanting to chat – sandwich). This way, 24 goal-object combinations required a yes-response, and 24 goal-object combinations required a no response. No new goals were added in the task, so only goals from the study phase were presented. Participants did not know in advance which and how many goal – object combinations would be presented. Prior to the 48 trials, 4 warming-up trials were presented. The 48 goal-object combinations were presented randomly.

Results

Retrieval percentage in retrieval phase

To assess whether participants retrieved the means to the same extent in the different retrieval-frequency conditions, the responses on the retrieval task were scored and the mean proportion of retrieved means was calculated. Participants were quite successful in retrieval of the means; the overall rate was 87%. There was no effect of retrieval-frequency, $F<1$.

Test phase

Trials on which participants indicated that the objects from the 24 goal-combinations from the study phase were no means to attain the goal (nearly 6% of the trials) as well as reaction times higher than three times the standard deviation above the mean (2% of the trials) were excluded from the analyses on the reaction times[1]. Because two different baselines were used, the data are analyzed and reported separately for each baseline.

Standard baseline

Reaction time. The response latencies were subjected to a 3 x 3 mixed model analysis of variance (ANOVA) with type of means (retrieved, standard baseline and nonretrieved competing means) as a within-participants factor and retrieval frequency (one, three, or nine times) as the between-participants factor. This analysis yielded a main effect of type of means, $F(2, 242) = 29.73$, $p < .001$. Simple comparison tests showed that participants responded faster to the retrieved means compared to the baseline means, $F(1, 121) = 39.52$, $p < .001$. However, participants were not slower to the nonretrieved competing means than the baseline means, $F(1, 121) = 1.11$, *ns*, suggesting that the non-retrieved competitors were not inhibited. Figure 2.1a displays the response latency difference scores between the retrieved and standard baseline means and between the nonretrieved competing and standard baseline means for the three retrieval-frequency conditions separately.

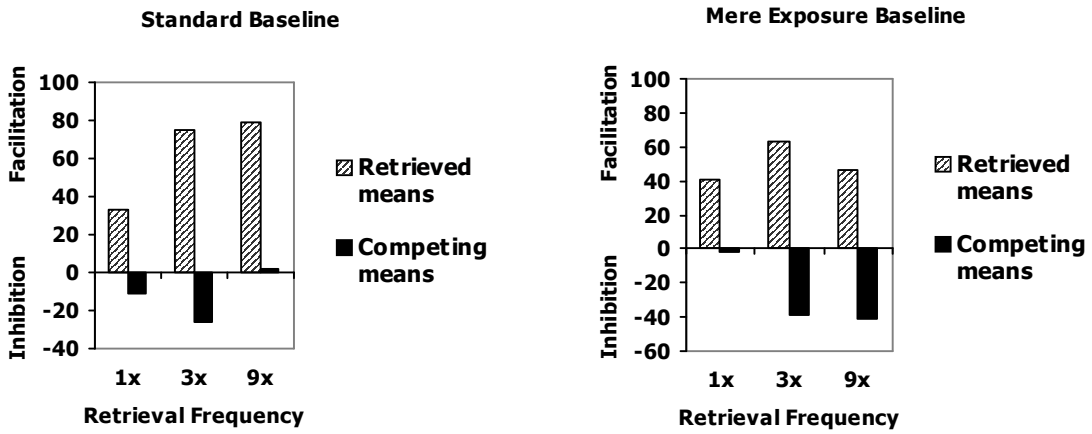

Figure 2.1. Mean difference scores in reaction time (ms) on the retrieved and competing means with the baseline means per retrieval frequency. The reaction times are presented separately for each type of baseline (analyses with the standard baseline are represented in Figure 2.1a and with the mere exposure baseline in Figure 2.1b). In both graphs, a positive score indicates facilitation and a negative score indicates inhibition.

According to our hypothesis, inhibition of the nonretrieved competitors is only assumed to occur after repeated retrieval of the target means (after three and nine times) and not after the initial retrieval (one time). To test this specific hypothesis, we examined the contrast of the inhibitory effects in the one-retrieval practice condition against those in the three- and the nine-retrieval practice conditions together (in weights: -2, 1, 1, respectively). No effects were found, *F's* < 1, *ns*. Furthermore, inhibited access was hypothesized to be equally found in the three- and nine-times retrieval practice conditions. The pattern in Figure 2.1a seems consistent with our hypothesis. To examine this specific prediction on inhibition after repeated retrieval, simple main effects were computed in which the differences in latencies between the nonretrieved competing means and the standard baseline means were examined separately for each retrieval-frequency condition. The analyses showed no inhibitory effect in any of the conditions, all *F*'s < 2, *ns*.

To sum up, with a standard baseline, no clear inhibition effects were found on the competitors, whereas a strong facilitation effect was found on the retrieved means.

Mere exposure baseline.

To reiterate, with the mere exposure baseline condition we tried to control for memory-trace advantages of the retrieved and nonretrieved competing means in the verification task. Accordingly, we again subjected the response latencies to a 3 x 3 ANOVA. Figure 2.1b displays the response latency difference scores between the mere exposure baseline means and the retrieved means on the one hand and the nonretrieved competitors on the other for the three retrieval-frequency conditions separately. As with the standard baseline, the analysis yielded a main effect of type of means, $F(2, 242) = 27.55$, $p < .001$. Simple comparison tests revealed that participants responded faster to the retrieved means compared to the mere exposure baseline means, $F(1, 121) = 25.77$, $p < .001$. It is important (and in contrast with the standard baseline) that analyses showed that participants responded *more slowly* to the nonretrieved competing means than to the mere exposure baseline means, $F(1, 121) = 6.16$, $p = .01$, indicating that, overall, the competitors were inhibited.

Again, the pattern in Figure 2.1b appears consistent with the notion that inhibited access to nonretrieved competing means only emerges when participants retrieve the target means more frequently. To test our specific hypothesis that inhibition should only be found after repeated retrieval and no difference should be found between the three- or nine-retrieval practices, we tested the contrast of the inhibitory effects in the one-retrieval practice condition against those in the three- and the nine-retrieval practice conditions together (in weights: -2, 1, 1, respectively). Although marginally significant, $F(1, 122) = 2.72$, $p = .10$, the results suggest that inhibition only occurred when the target means was repeatedly retrieved for the goal (the inhibitory effect did not differ between the three- and nine-times retrieval practice conditions, $F(1, 122) = 0.02$, *ns*). We conducted simple comparison tests to examine the difference between nonretrieved competing means and mere

exposure baseline means for each retrieval-frequency condition separately. These analyses revealed that one-time retrieval practice did not inhibit the competing means, $F(1, 123) = 0.01$, *ns*, whereas after three- and nine-times retrieval practices inhibited these means, $F(1, 123) = 3.82$, $p = .05$, and $F(1, 123) = 4.68$, $p = .03$, respectively.

Discussion

The results of the first experiment provide tentative evidence that access to the competitors was only inhibited after repeated retrieval of the target means. A single retrieval did not inhibit the competing means but repeated retrieval of the target means did cause inhibited access to the competing means. Inhibition did not decrease with further repetitive retrieval: No inhibitory difference was found upon three and nine retrieval practices of the target means for the goal.

The findings of Study 2.1 were obtained by employing a goal-means verification task. Responses on this task partly rely on the association between the means and the specified goal. Because of this association aspect of the task, we had to control for memory traces in the retrieval task to observe inhibition of the competing means. To provide further support for our ideas, Study 2.2 aimed to replicate and extend the inhibitory findings by using a different accessibility measure that does not rely on association between goals and means. For this purpose, in Study 2.2 we used a means-recognition task to measure the speed of retrieving the means from memory (Veling & Van Knippenberg, 2004). A recognition task assesses the unique accessibility status of the means during testing, thereby excluding the memory trace advantage of goal-means links resulting from the retrieval phase. Accordingly, only the standard baseline condition was used.

Study 2.2

Method

Participants and design

One hundred and thirty-five Dutch undergraduates received €5 in return for their participation. Participants were randomly assigned to either one of the following three retrieval-frequency conditions: one, three, or nine times.

Material and procedure

The materials, instructions and procedure were similar to those used in Study 2.1, but with a few changes. In this experiment a means-recognition task was used in the test phase to measure the accessibility of the means studied in the study phase. Furthermore, 18 goal-means combinations were presented in the study phase: nine goals each associated to two means. In this phase, two blocks were again created and in each block the nine goals were presented with one of the means. Before, between, and after the two blocks, two filler goal-means combinations were used to prevent primacy and recency effects from occurring. After the retrieval phase, which was also similar to the one used in Study 2.1, three different categories of means were created that each included six means: retrieved means, nonretrieved competing means and (standard) baseline means. Again, participants had to complete the two-letters means string within 5 sec in the retrieval phase and the same rules and instructions applied as in the first experiment. The baseline means were the nonretrieved means of the goals that were not presented during the retrieval phase.

The final phase of the experiment consisted of a means-recognition task in which participants had to indicate as fast and as accurately as possible whether the presented object was a means they had previously studied in the experiment. The faster participants were able to recognize the means, the more accessible the means were. In total, 36 objects were presented. The 18 objects from the study phase provided the "yes" answers and 18 different objects not presented in the study phase provided the "no" answers. All objects were presented randomly, preceded by four warm-up trials.

Results

Retrieval percentage in retrieval phase

We assessed whether participants retrieved the means to the same extent in the different retrieval-frequency conditions. The mean proportions of accurate retrieval showed that participants were very accurate in retrieval of these means; the overall retrieval rate was 95%. No differences in retrieval success were found between the different retrieval-frequency conditions, $F < 2$, *ns*.

Test phase

Reaction time. Incorrect recognition responses (the number of accurate recognition was reasonably high: 80%) as well as reaction times higher than three times the standard deviation above the mean (2% of trials) were excluded from the analyses[2]. The analyses consisted of an 3 x 3 mixed model analysis of variance (ANOVA) with type of means (retrieved, baseline, and nonretrieved competing means) as the within-participants factor and retrieval-frequency (one, three, or nine times) as the between-participants factor. Figure 2.2 shows the response latency difference scores between the baseline means and the retrieved means on the one hand and the nonretrieved competitors on the other for the three retrieval-frequency conditions separately. A main effect of type of means was found, $F(2, 234) = 61.97$, $p < .001$. Simple comparison tests showed that, overall, participants recognized the retrieved means faster than the baseline means, $F(1, 117) = 120.99$, $p < .001$. Also, an inhibition effect was found, $F(1, 117) = 4.23$, $p = .04$; participants recognized the competing means more slowly than the baseline means.

Similar to Study 2.1, the pattern in Figure 2.2 suggests that nonretrieved competitors were more strongly inhibited when participants retrieved the target means more frequently. Again we expected to find inhibition of the competing means only upon repeated retrieval of the target means. To examine this effect, we tested the contrast of the inhibitory effects, similar to Study 2.1, in the one-retrieval practice condition against those in the three- and the nine-retrieval practice conditions together (in weights: -2, 1, 1, respectively). In accordance with the findings in Study 2.1, the results suggest that inhibition only occurred when the target means was repeatedly retrieved for the goal,

$F(1, 118) = 4.02$, $p = .047$ (the inhibitory effect did not differ between three- and nine-retrieval practice conditions, $F < 1$). Subsequently, we conducted simple comparison tests to examine the difference between nonretrieved

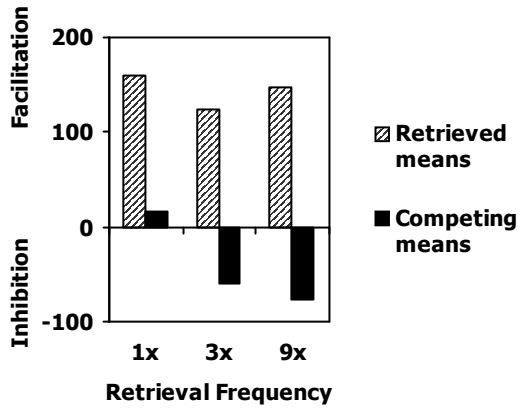

Figure 2.2. Mean difference scores in reaction time (ms) on the retrieved and competing means with the baseline means per retrieval frequency. A positive score indicates facilitation and a negative score indicates inhibition.

competitors and baseline means for each retrieval-frequency condition separately. These analyses showed no inhibition effect after one-retrieval practice, $F(1, 117) = 0.20$, *ns*. However, three-times retrieval practice caused inhibition of the competing means, $F(1, 117) = 3.23$, $p = .07$ (albeit only marginal significant), and after nine-times retrieval practice these means were significantly inhibited, $F(1, 117) = 5.03$, $p = .03$. These findings on the recognition task thus replicate those obtained in the goal-means verification task in Study 2.1.

Study 2.3

So far, the findings of two studies suggest that repeated retrieval of a target means from memory to attain that goal causes inhibition of competing means associated with the same goal. This inhibition effect is assumed to emerge to prevent interference of the competing means that otherwise will

hamper the retrieval process. We argued that this inhibition occurs implicitly, that is, inhibited access to competing means in memory upon retrieval of the target means emerges without explicit intent or instructions to do so. However, it may be argued that our experimental setup may encourage participants to use a more deliberate strategy in which they explicitly suppress the competing means from memory to retrieve the target means faster and more accurate[3]. Specifically, participants in both studies were first introduced to two means (e.g., computer, telephone) that both serve a given goal (wanting to chat) and were then asked to repeatedly retrieve a target means (e.g., computer) upon the presentation of a goal. In order to complete this retrieval task successfully, participants would have been well served by strategically inhibiting the competing means (e.g., "I'd better put *telephone* out of mind to do this task as quickly and accurately as I can"). In other words, inhibition of the competitors was likely a strategy in which participants explicitly engaged during the retrieval phase to help them perform the retrieval task quickly and accurately.

To investigate this strategic suppression account, we designed a third experiment in which we instructed participants either to use such a suppression strategy or not to, by encouraging them to put the competing means out of mind before retrieving the target means. If the inhibition of competing means is the result of a strategic suppression process then these means should be recognized slower than baseline means regardless of the instruction conditions. However, there may be another possibility. Specifically, because participants in the strategic condition have the goal to put the competing means out of mind before retrieving the target means, it is likely that the competitors become more accessible and hence more quickly recognized than the baseline means. In other words, under conditions of strategic suppression the competing means may be facilitated rather than inhibited as a result of intentionally inhibiting them (cf. Wegner, 1994).

Method

Participants and design

Seventy-three Dutch undergraduates received €5 in return for their participation. Participants were randomly assigned to either one of the following two retrieval strategy conditions: instruction versus no instruction.

Material and procedure

The materials, instructions, and procedure were similar to those used in Study 2.2, except for a few changes in the retrieval phase. In this experiment all participants retrieved the means nine times. To test whether the competing means were inhibited as a result of a deliberate strategy, half of the participants were instructed to actively apply the strategy to put the competing means out of mind prior to the retrieval of each target means. They were told that this strategy would help them to retrieve the target means (associated to the same goal) more rapidly and more accurately. The other half of the participants did not receive this instruction.

After the retrieval phase, three different categories of means were created that each included six means: retrieved means, nonretrieved competing means and (standard) baseline means. Again, participants had to complete the two-letters means string within 5 sec in the retrieval phase. The baseline means were the nonretrieved means of the goals that were not presented during the retrieval phase. Accessibility of the different means was assessed with a means recognition task and the same rules and instructions applied as in the second study.

Following the recognition task, we checked the instruction manipulation by asking participants to indicate on a 9-point scale ranging from "not at all" (1) to "very strongly" (9) to what extent they tried to put the competing means out of mind to be able to retrieve the target means faster and more accurately.

Results

Retrieval percentage in retrieval phase

We assessed whether participants retrieved the means to the same extent in both instruction conditions. The mean proportions of accurate retrieval showed that participants were very accurate in retrieval of these means; the

overall retrieval rate was 97%. No differences in retrieval success were found between the different instruction conditions, $F < 1$, *ns*.

Retrieval instruction check

An independent-samples *t* test was conducted to examine whether participants in instruction condition differed from those in the no instruction condition in their effort not to think about the competing means during the retrieval phase. The test was significant, $t(71) = -2.89$, $p = .005$; participants in the instruction condition more strongly tried to avoid thinking about the competing means ($M = 4.71$, $SD = 2.39$) than did the participants in the no-instruction condition ($M = 3.13$, $SD = 2.22$). The results indicate that participants adhered to our instructions.

Test phase

Incorrect recognition responses (the number of accurate recognitions was reasonably high: 85%) as well as reaction times higher than three times the standard deviation above the mean (nearly 3 % of trials) were excluded from the analyses. The analyses consisted of a 3 x 2 mixed model analyses of variance (ANOVA) with type of means (retrieved, baseline, and nonretrieved competing means) as the within-participants factor and instruction (instruction versus no-instruction) as the between-participants factor. Figure 2.3 shows the response latency difference scores between the baseline means and the retrieved means on the one hand and the nonretrieved competing means on the other for the two instruction conditions separately.

Reaction times. We found a main effect of type of means, $F(2, 142) = 54.89$, $p < .001$, as well as an interaction effect between type of means and instruction condition, $F(2, 142) = 7.41$, $p = .001$. Simple comparison tests showed that, overall, participants recognized the retrieved means faster than the baseline means, $F(1, 71) = 95.92$, $p < .001$; access to the retrieved means was facilitated. No overall inhibition effect of the nonretrieved competing means was found, $F(1, 71) = 0.00$, *ns*. However, the differences between the baseline means and the competing means were different between the two instruction conditions, $F(1, 71) = 13.44$, $p < .001$; in the no-instruction condition

participants were slower to recognize the competing means in comparison to the baseline means, $F(1, 72) = 5.40$, $p = .023$; the competing means were inhibited. However, in the instruction condition participants were *faster* to

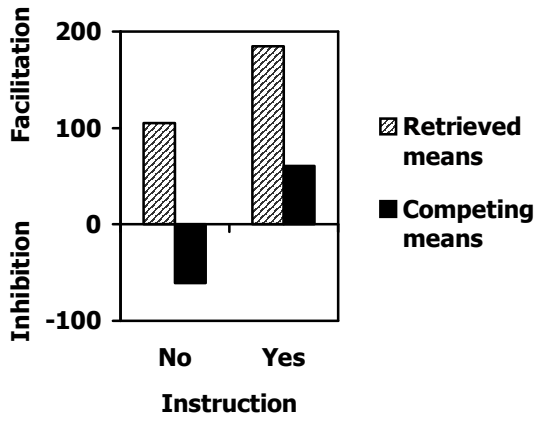

Figure 2.3. Mean difference scores in reaction time (ms) on the retrieved and competing means with the baseline means per instruction condition. A positive score indicates facilitation and a negative score indicates inhibition.

recognize the competing means than the baseline means, $F(1, 72) = 7.32$, $p = .009$. Hence, the competing means were facilitated in the instruction condition.

The present data reveal several noteworthy findings. First, the results in the no-instruction condition replicated those of Studies 2.1 and 2.2; access to the competing means was inhibited upon repeated retrieval of the target means for the goal. Second, the findings in the instruction condition indicate that the use of a deliberate strategy to put the competitors out of mind prior to the retrieval of the target means *facilitated* access to these means. Hence, the inhibitory effect found in the previous studies does not seem to result from a deliberate suppression strategy. More likely, they represent an implicit process.

General Discussion

The present research aimed to gain more insight into the cognitive process underlying the initial stage of habit formation in a context where several means

are associated and available for the goal. Specifically, we examined the influence of retrieval of the same means to attain specified goals on the accessibility of competing means for that same goal as a function of the retrieval frequency of the target means. The results of three studies show that accessibility of the retrieved means was facilitated and the accessibility of the competing means was inhibited. Is it important that the findings of Studies 2.1 and 2.2 reveal that the inhibition effect of these competitors was determined by the retrieval frequency of the target means. It was found that the means were not inhibited after a single retrieval from memory but that repetitive retrieval (three or nine times) did lead to inhibition of these means. The evidence for these inhibitory effects after repeated retrieval of target means was provided by two different response latency measures: a goal-means verification task and a means-recognition task. The present findings thus indicate that both facilitative and inhibitory processes underlie the initiation of habit formation.

We argued that inhibition in the initial stage of habit formation to use a specific target means requires practice but that this inhibition occurs implicitly. Specifically, to select the target means it needs to be retrieved from memory in an efficient manner, that is, without interference from competing means. For that reason, an inhibitory link is created in the memory system between the means during succeeding retrieval to inhibit access to the competitors upon goal activation, thereby preventing their mental representation from becoming consciously accessible. Therefore, these competitors are inhibited without strategically suppressing them. In an attempt to test this notion more directly, Study 2.3 compared the inhibition effects obtained in Studies 2.1 and 2.2 with those occurring when participants are encouraged to deliberately suppress competing means. The results indicated that access to the competing means was inhibited when no such deliberate suppression strategy was given (replicating the data of Studies 2.1 and 2.2) and explicitly suppressing the competitors prior to the retrieval of the target means did not cause inhibition and even resulted in facilitated access to these means. This dissociative pattern of results provides more convincing evidence for the assumption that the

inhibition of competing means during the formation of goal-directed habits can emerge from an implicit process. Accordingly, although one may experience one's decision to use means for goal pursuit as being based on consciously rejecting competing alternatives, our data suggest that these competitors can be inhibited before one become aware of them. These findings are consistent with other models of inhibition, in which the interference of competing information is solved before this information gains access to consciousness (M. C. Anderson & Green, 2001; Dijksterhuis & Van Knippenberg, 1998).

Our findings concur with recent work on the role of inhibition in goal-directed behavior (Mayr, 2002) and, moreover, with the findings of Shah and colleagues' (2002; see also Shah, 2005) in their work on their goal-shielding model. The present research, however, extends this research in two important ways. First, in these studies the goal-means network was taken into account more directly as opposed to the research of Shah and colleagues (2002). In Shah and et al.'s study participants were primed with means (or subgoals) that caused inhibition of competing means, and it was assumed that these effects occurred because the means were connected to the same goal. In the present study, specific goal-means links were created by asking participants to encode the instrumental relation between the means and the goal and, moreover, the accessibility of the different means was assessed after retrieval of the means for goal attainment. Secondly, inhibition only emerged after repeated retrieval of a target means from memory. Although Shah et al. (2002) speculated about the temporal learning of inhibition in goal-systems, they did not investigate this assumption. Our findings, therefore, allow for a firmer conclusion that inhibition of subgoals or means that compete for attention upon the activation of a (higher) goal has to be practiced or learned (see also Chan et al., 2001).

It should be noted that the present study investigated the initial stage of the formation of goal-directed habits by exploring the inhibition of competing means as a result of maximally nine repetitions. We are unable to draw conclusions about the role of inhibition in a more advanced stage of the formation process. Although it is difficult to say how many times the retrieval

and selection of the target means have to be implemented to categorize the goal-directed behavior as truly habitual (e.g., Aarts et al., 1998; Ronis et al., 1989), it may be worthwhile to speculate on the nature of the inhibitory control of competing means when such habits are in place. First, we did find that competing means are inhibited after nine retrieval performances. This sustained inhibition suggests that competitors remain part of the goal-means network during the formation of habits. However, what will happen when the number of repetitions further increases and habits are established? Are competing means still inhibited? Two possibilities are discussed here.

First, the development of habits may be rather slow, for example, when habits are formed under rather unstable circumstances (Danner, Aarts, & De Vries, in press; Ouellette & Wood, 1998). For instance, it may be that habits are less easily formed when the interference of competing means is stronger. Strong interference can be the result of two different processes: a high number of competing means associated to the goal or a strong association between the goal and the competing means (Bäuml, 1998; Shivde & Anderson, 2001). Accordingly, a habit to use a target means for attainment of the goal might establish more slowly when numerous competing means are available for goal pursuit (e.g., when wanting to keep one's options open) or when one competing means is strongly associated to the goal (which may be the case when intending to change an existing habit). Inhibition, then, may sustain even after a high number of practice trials. Second, inhibition may dwindle because the competitors lose their functionality as alternatives when the same target means is used over and again in the past. In that case, the association between the goal and competing means decreases in strength and, as a consequence, interference of these means disappears as a result of an associative decrement or extinction effect. An interesting avenue for further research, then, is to investigate these processes in more detail to fully understand and appreciate whether and how inhibitory control shapes and maintains goal-directed habits.

Future directions

This investigation was conducted as a first attempt to analyze the process of habit formation in a context where several means are available for goal pursuit. Our research still has a preliminary status and thus leaves a number of questions open for further examination. First, whereas this research focused on the cognitive mechanism underlying the inhibition of means in a goal-means network, motivational aspects are also an important part of goal-directed behavior (Geen, 1995; Gollwitzer & Moskowitz, 1996). For instance, Shah and colleagues (2002) showed that their goal-shielding effects were stronger when the self-reported commitment (or importance) to pursue the goal was stronger. These findings suggest that motivation may moderate inhibition effects of competing means. It should be noted, though, that commitment and frequency of goal pursuit may be highly correlated; people who are motivated to pursue a goal are more likely to repeat that goal pursuit more often, especially when goal pursuit is successful (Aarts, Paulussen, & Schaalma, 1997a; Weiner, 1985). Thus, whereas the current data did not show effects of motivation on inhibition, they may have demonstrated a potential mediator of motivation on inhibition during habit formation. However, because this line of thought is not directly tested in the present studies, it awaits further empirical scrutiny.

Another issue pertains to the notion that interference and, hence, inhibition only occurs when information competes for attention or behavior. Because people's behavior system usually allows them to do one thing at the same time, inhibition plays an important role in sequential aspects of goal-directed behavior even though the performance of subactions (e.g., first turning left, then turning right) facilitate goal achievement (e.g., Mayr, 2002). However, in the context of goal-means network, it is suggested that inhibition only emerges when the means are competitive. This notion is supported by recent work. Shah and colleagues (2002) showed that the degree of competition between subgoals or means was positively related to the goal shielding effect. That is, "… inhibition of alternative goals was found to be more pronounced when they serve the same overarching purpose as the focal goal, but lessened when the alternative goals facilitate focal goal attainment" (Shah et al., 2002, p. 1261).

In the present research the means were encoded as competitors for the given goals and, in line with Shah and colleagues' findings, these means were inhibited when participants repeatedly retrieved the same means for attainment of the same goal. These findings, though, leave open the possibility that it was not so much the competitive nature of the means that caused the inhibition effect but simply the fact that these means were associated to the goal (albeit competitive or complementary means) and therefore competed for attention during the retrieval. Although we believe that the formation of goal-directed habits may benefit from the inhibition of any interfering information at the moment of retrieving habitual means, future research could address how the nature of the means may, cognitively and behaviorally, facilitate or hinder the formation of habits.

Concluding remarks

We observed that competing means are inhibited as a result of repeated retrieval of target means for goal attainment. Our studies suggest that inhibitory control may play an important role in the early stage of the formation of goal-directed habits. Inhibition is a functional mechanism to ease goal attainment: People are able to make fast and reliable decisions about how to attain their goal by getting rid of the interference of accessible means that otherwise compete for attention. So the more often one chooses fruit salad when ordering dessert, the less likely ice cream comes to mind.

[1] Analysis of variance (ANOVA) on the "no" responses showed that participants less frequently responded with "no" to retrieved means than to baseline and competing means. However, because controlling for these differences in the ANOVA with the reaction times as dependent variable did not change the reported pattern of results, they are not further reported in the analyses.

[2] ANOVA on the recognition accuracy scores showed that participants' accuracy scores in Study 2.2 and Study 2.3 were higher for retrieved means than for baseline and competing means. However, because controlling for these differences in the ANOVA with the reaction times as dependent variable did not change the reported pattern of results, they are not further reported in the analyses.

[3] We thank one of the reviewers for suggesting this alternative explanation.

Chapter 3

Strong habit intrusion in goal-directed behavior: Shielding intentions against habits

This chapter is based on Danner, U.N., Aarts, H., & De Vries, N.K. (2007). Strong habit intrusion in goal-directed behavior: Shielding intentions against habits. *Manuscript under review*.

People frequently form behavioral intentions to attain their everyday goals. Goal attainment can often be accomplished with the use of several different means, e.g. one can eat a hamburger or a salad for lunch. However, to realize their goal people usually select or intend to use only one of these means. Sometimes, these intentions can be carried out immediately, whereas on other occasions intentions are postponed until an adequate opportunity presents itself. In both cases, it is necessary to access the proper representation of the intended means in memory and to execute the intention in order to attain the desired goal (e.g., Goschke & Kuhl, 1993; Marsh et al., 1998).

As a result of personal practice and history, people often have, in principle, two qualitatively different means at their disposal to attain their goals. First of all, they can intend to use the means they already repeatedly selected in the past, and thus goal attainment takes on a habitual process. In this case, the intention to use the habitual means is directly activated in mind, and alternative means may not be involved in the selection process (Aarts & Dijksterhuis, 2000a; Aarts et al., 1998). As a second type of means to attain their goals people may also intend to deviate from one's habitual way of goal pursuit, i.e. performing alternative non-habitual goal-directed behavior. However, several classifications of human error and action slips (Heckhausen & Beckmann, 1990; Norman, 1981; Reason, 1979; see also James, 1890) suggest that the enactment of such counter-habitual intentions can be rather difficult. That is, people have to deal with the interference of the habitual means when accessing and maintaining the intention to use the non-habitual means in memory. Whereas this notion of strong habit intrusions seems rather obvious, so far research on the cognitive processes underlying the role of intentions in goal-directed habits in a multiple means context has devoted only little empirical attention to this issue. This study aims to explore this topic by examining how people handle the potential interference caused by the activation of the habitual means upon the formation of intention to use non-habitual means. Gaining more insight in the regulatory processes underlying this type of intention is important to better understand the success and difficulties of changing habits.

Contemporary social-cognitive approaches to goal pursuit conceptualize goal-directed behavior as knowledge structures in which the mental representation of goals and the means are interconnected. Furthermore, it is assumed that means are activated by their association with the goal (Aarts & Dijksterhuis, 2000a; Bargh, 1990a; Kruglanski et al., 2002). Performing the same goal-directed behavior frequently leads to stronger associations between the goal and the means (i.e., to the formation of a habit) and consequently, idiosyncratically learned goal-means links in memory gain strength. As a result, activation of these goals spreads automatically to the associated instrumental actions (cf. J. R. Anderson, 1993; Mäntylä, 1993) and people are capable of directly accessing and selecting the habitual means upon the instigation of the goal. Habits are therefore considered to be a form of automatic goal-directed behavior (Aarts & Dijksterhuis, 2000a; Moskowitz et al., 2004).

Aarts and Dijksterhuis (2000a) directly tested the habitual goal-means idea underlying automatic goal pursuit in the realm of travel behavior. In one set of studies, they employed a response latency paradigm to demonstrate that habitual bicycle users respond faster to the means "bicycle" after priming of the goal of traveling to a certain destination. For example, habitual and non-habitual bikers were primed with the goal to travel to the university. A subsequent reaction time task measured the accessibility of the concept of bicycle. Results showed that the travel goal facilitated access to the concept of bicycle, but only for those persons who regularly used a bicycle for this trip, suggesting that cycling was automatically activated by the goal of traveling to the university for those persons. Sheeran, Aarts et al. (2005) recently replicated this habitual goal-means activation process in the realm of overt drinking behavior.

Whereas people may be rather efficient in the implementation of habitual goal-directed behavior, more interesting is the intention to deviate from one's habit, i.e. using alternative or non-habitual means to pursue the same goal other than the habitual one (e.g., one usually takes a hamburger for lunch, but next lunch one intends to have a salad). To act on this intention, it is necessary

that the representation of the non-habitual means is accessed and maintained in memory (J. R. Anderson, 1983; Goschke & Kuhl, 1993). However, the intention to use the non-habitual means is likely to be threatened by the immediate activation of the habitual means, as this means is automatically triggered upon the instigation of the goal (e.g., when the representation of hamburger is directly accessed upon the goal of having lunch). Hence, the representation of the habitual means will interfere with the intention to use the non-habitual one (Cooper & Shallice, 2000; Kruglanski et al., 2002) and in the end the interference can cause the intention to cease and to be forgotten. How, then, do people deal with or regulate these counter-habitual intentions in memory? Specifically, what kind of mechanism may aid them to overcome the interference of the habitual means and to increase the probability to act on the intention?

One way in which people may effectively regulate their intention to use non-habitual means is by inhibiting the mental representation of the habitual means. That is, to engage in the non-habitual behavior when the proper situation is encountered, potential distraction has to be thwarted to access and maintain the intentions in memory (Gollwitzer, 1990; Norman & Shallice, 1986). It is known that the inhibition of interfering information serves an important role in preventing such hindrances (Dagenbach & Carr, 1994). Inhibitory processes have been found to regulate memory for several purposes, e.g. memory retrieval (M.C. Anderson, 2003; Danner, Aarts, & De Vries, 2007a) selective attention (Tipper, 2001) and action performance (Mayr, 2002), and have been argued to be functional to shield goal pursuit from distraction caused by accessible competing information (Cooper & Shallice, 2000; Kruglanski et al., 2002; Kuhl & Beckmann, 1985). Based on this line of reasoning, we argue that the representation of the habitual means is inhibited to prevent it from interfering with the intention to use the non-habitual means. Furthermore, we propose that the intention to use the habitual means will not cause inhibited access to alternative (non-habitual) means, as these latter means are not

strongly (or to a lesser extent) associated with the goal, and hence do not interfere with the intention to use the habitual means (cf. Bäuml, 1998).

Whereas intentions to use non-habitual means to attain goals may be shielded by inhibiting access to habitual means, empirical research on the role of such intentions in inhibitory processes of goal-directed behavior is rather scarce. Although some studies argue that inhibition occurs to fend off distracting information as a result of the formation of intentions (Marsh et al., 1998), a recent study by Veling and Van Knippenberg (2006) addresses this issue more directly. In their study, Veling and Van Knippenberg asked their participants to memorize several different category-item combinations, e.g. chair and table as items for the category furniture and lion and monkey as items for the category animals. Next, participants formed a specific intention they had to act upon later on, i.e. removing specified exemplars of a category (e.g., table) presented on the screen during a subsequent lexical decision task by pressing the space bar. The rationale here, then, is that the intention to press to the item of table should inhibit the item of chair, in comparison to the other two items (lion and monkey) unrelated to the category of furniture. The lexical task was given to assess the accessibility of related (chair) and control cues (monkey, lion) of the memorized category-item combinations. The results indicated that access to information semantically related to the content of the intention (chair) was inhibited in comparison to information not semantically related to the intention (monkey and lion).

The aim of the current research was to extend these findings in two important ways. First, we examined the role of intentions in the inhibition processes involved in goal-directed behavior in a multiple means context. Second, we analyzed the habitual status of the means in this process. Specifically, based on the reasoning addressed above we hypothesized and tested that intentions to use non-habitual means to attain goals inhibit access to habitual means for those goals, whereas the intention to use habitual means was not expected to inhibit access to the non-habitual means. This latter hypothesis is based on models of action control that propose that through

practice, the most accessible behavior representation (i.e., habitual means) guides behavior because it is more easily accessed (e.g., Aarts, 2007; Logan & Cowan, 1984; Norman & Shallice, 1986). As a result, alternative means do not interfere and are not inhibited.

Moreover, whereas previous work employed a nomothetic approach to study the role of habits in the mental accessibility of means (e.g., in the Aarts and Dijksterhuis 2000a study, all participants were exposed to the same travel destinations and tested for bicycle use as a function of individual differences in habit strength) an extra novelty in the current studies was the use of idiosyncratic goal-means combinations that enables us to use participants' personal existing goal-means links. It is this functional relation between goals and means, i.e. the means are considered instrumental for attainment of the goal, that makes it different from merely a semantic link (Kruglanski et al., 2002; Moskowitz et al., 2004).

Two studies were conducted to test our hypothesis. In both studies, participants were asked to generate for a set of goals a means they usually use (i.e., the habitual means) and a means they utilize as an alternative in case the first means is not available (i.e., the non-habitual means). In addition, by asking participants to generate these means, each goal was connected to two unique means that were both functionally related to the goal but differed in terms of the past usage of this means for goal achievement. Through the use of this idiosyncratic approach, participants provided means that they perceived instrumental for attainment of the goals as they used these means themselves.

Extending previous work on the mental accessibility of goal-directed habits (Aarts & Dijksterhuis, 2000a; Sheeran et al., 2005), the first study aimed to demonstrate the potential interference of habitual means by testing differences between the habitual and non-habitual means in terms of their accessibility and repetitive nature in attaining the goal. Whereas previous work tested accessibility differences between people with a cycling or drinking habit and people without this habit (Aarts & Dijksterhuis, 2000a; Sheeran et al., 2005), we assessed within participants whether the two qualitatively distinct means

(i.e., habitual and non-habitual) differed in accessibility to attain the same goal. Interference, and thus inhibition, is only expected to occur when one of the means is more easily accessed than the other means. We measured the accessibility under different conditions of (habitual vs. non-habitual) intentions by way of a response latency task in which accessibility of the means was assessed upon priming of the related goal. We expected the habitual means to be more easily accessed upon priming the goal in comparison to the non-habitual means, and this difference in the strength of spontaneous activation should be attributed to differences in frequency of using the means.

In the second study we examined how accessibility of the habitual and non-habitual means is influenced by the formation of intentions to use the habitual and non-habitual means. In this study, participants were asked to form intentions to use one of their means for some of the goals. In one condition participants were asked to use the habitual means for this purpose and in the other condition they were asked to use the non-habitual means. Subsequently, we measured accessibility of the means in a recognition task. Evidence for inhibited access is established if recognition of the means related to the goals for which intentions are formed is slower than recognition of the means for which no intentions are formed.

Study 3.1

Method

Participants and Design. Fifty-one students (38 females and 13 men) from the Utrecht University participated in the study for either €4 or course credit. The study consisted of one within participant factor: type of means (habitual vs. non-habitual means).

Procedure. Upon entrance in the lab, participants were seated in front of a computer in a separate cubicle. All the necessary instructions were presented on the screen. Participants were told that they were participating in a study to investigate how students pursue their daily life goals. In the first task,

participants were asked to generate a habitual and a non-habitual means for five different goals (having lunch, playing sports, watching television, visiting a pub and studying) by indicating how they usually pursue the goal and how they pursue the goal when the habitual means is not available. A pilot study showed that our sample of students perceive the selected goals as important and considered them as goals they regularly pursue. These idiosyncratic habitual and non-habitual means were the stimuli that were subsequently used in the remaining part of the study.

After a filler task (that lasted 5 minutes to remove all generated means from short-term memory), the experiment continued with the goal-means reaction time task. This task was conducted to measure the accessibility of the two types of goal-directed means; that is the ease of accessing the habitual and non-habitual means upon presentation of the goal. Accordingly, participants were presented with one of the goals followed by another word and they had to indicate as fast as possible whether or not the presented word is a means to attain the goal by pressing a "yes" or a "no" key on the keyboard (see Aarts & Dijksterhuis, 2000a; for a similar procedure). The accessibility measure was operationalized as the speed of responding with "yes" to the critical means. The reaction time task consisted of an equal amount of yes responses (the goal-means combinations that were generated previously, e.g. having lunch - hamburger) and no responses (the goal followed by a word not instrumental for pursuit of the goal, e.g. having lunch - telephone). Each trial started with a fixation cross appearing in the middle of the screen (500 ms), after which the goal word was presented (300 ms), a pause (100 ms) and finally followed by another word. The word remained on the screen until participants pressed a key. Response latencies were measured in ms. The intertrial time was 1.5 s.

At the end of the session, we assessed how often the goal-directed behavior was performed in the past. Each goal-means combination was presented separately and participants were asked to indicate how often they have used the means for pursuit of the goal in the past four weeks by reporting the number of the times the goal-directed behavior was actually performed.

Finally, several demographics were assessed and participants were thanked and paid.

Results and discussion

Frequency. The frequency scores for the five habitual goal-directed means as well as for the five non-habitual means were averaged. These frequency scores were subjected to a within participants model analysis of variance (ANOVA) with type of means (habitual vs. non-habitual means) as the within participants factor. As was expected, a strong effect of type of means was found, $F(1, 50) = 191.21$, $p < .001$; participants used the habitual means substantially more often for goal attainment ($M = 10.25$, $SD = 4.03$) than the non-habitual means ($M = 2.95$, $SD = 1.31$). In other words, our distinction between habitual and non-habitual means is highly related to differences in frequency of using the means.

Accessibility. Trials on which participants indicated that the means they generated themselves for the goal were no instrumental means (nearly 6 % of the trials), as well as reaction latencies higher than three standard deviations above the mean (nearly 1 % of the trials), were excluded from the analyses. Subsequently, the response latencies on the five habitual as well as on the five non-habitual means were averaged. The response latencies were subjected to a within participants model analysis of variance (ANOVA) with type of means (habitual vs. non-habitual means) as the within participants factor. This analysis yielded an effect of type of means, $F(1, 50) = 9.30$, $p = .004$; participants were faster to indicate that their habitual means was a means instrumental for goal attainment ($M = 587.56$, $SD = 100.82$) than their non-habitual means for the same goal ($M = 636.46$, $SD = 133.52$). These results suggest that the mental representation of the habitual means was more accessible upon instigation of the goal than the representation of the non-habitual means.[1]

We hypothesized that differences in accessibility were attributable to differences in goal-directed behavior repetition. To test this assumption, we subjected the response latencies to an analysis of covariance (ANCOVA) in the

same way as before, but this time controlling for number of instances the goal-directed behavior was performed. The results did no longer show a difference in response latency, $F(1, 49) = 0.01$, *ns*.

In short, the findings replicate and extend previous work on the accessibility of habitual goal-directed behavior (Aarts & Dijksterhuis, 2000a; Sheeran et al., 2005). First, results of Study 3.1 showed that habitual means were more accessible when confronted with the goal than the non-habitual means, *because* they were used more often for goal pursuit. Second, these results were obtained by using idiosyncratic (or personal) rather than nomothetic (or semantic) goal-means relations, indicating that the accessibility of habitual and non-habitual means upon goal priming differs as a result of personally acquired goal-directed behaviors. Importantly, the fact that habitual means are more readily accessible upon goal priming than the non-habitual (alternative) means suggest that habitual means form a potential threat in interfering with the intention to use a non-habitual means to attain a goal. Interference that may be resolved by inhibiting the access to the habitual means. The purpose of Study 3.2 was to test this notion.

Study 3.2

The second study aimed to test how the accessibility of the different means is influenced by the intention to either use a habitual or a non-habitual means for the goal. Based on the findings of Study 3.1, we hypothesized that the formation of the intention to use the habitual means will facilitate access to the representation of that means (measured as faster responses in a subsequent means recognition task) without interference from the non-habitual means. However, the intention to use a non-habitual means was expected to cause the habitual means to interfere with that intention, and as a consequence will be inhibited. So we expected the means on which an intention was formed to be enhanced accessible in both intention conditions (in line with other research; Freeman & Ellis, 2003; Goschke & Kuhl, 1993; Marsh et al., 1998), while we

expected only the habitual means in the intention to use the non-habitual means condition to be inhibited.

To test whether a facilitation or inhibition effect occurs, a comparison with a proper baseline is needed (e.g., Danner et al., 2007a). Study 3.2 consisted of six goals and participants had to form intentions to use the habitual or non-habitual means to attain the goals on only three of the six goals. Consequently, the intended and non-intended means of the three goals comprised the test means and the means associated to the remaining three goals were the baseline (or control) means. By comparing the accessibility of the intended (habitual or non-habitual) test means with the control (habitual or non-habitual) means we can assess the occurrence of a facilitation effect, and by comparing the accessibility of the non-intended (habitual or non-habitual) test means with the control (habitual or non-habitual) means we can assess the emergence of an inhibition effect.

Method

Participants and design. One hundred and seventeen students (33 men and 84 women) from the Utrecht University participated in exchange for either €4 or course credit. Participants were randomly assigned to either one of the two intention conditions: habitual means versus non-habitual means. The remaining two factors were both within-participants factors: accessibility of the means (habitual versus non-habitual) and type of means (test means versus control means).

Procedure. Upon entrance of the lab, participants were greeted by the experimenter and placed behind a computer in a separate cubicle. All instructions were provided on the screen. The first task was to generate means for the goals in an identical manner as in Study 3.1. Hence, for six different goals two means were generated: a habitual and a non-habitual means. The second task consisted of an unrelated filler task to remove all generated means from short-term memory. The task lasted five minutes.

Next, the intention instructions were provided. The intentions were embedded in a cover story to ensure that participants were willing to form and maintain intentions and to act on these later on (cf. Goschke & Kuhl, 1993). We told participants that they had to execute an extra task at the end of the experiment, allegedly to test their ability to use some of their personally indicated means to attain their goals. Participants thus either formed intentions to use their habitual means for the goals or to use the non-habitual means. To motivate participants to keep the intentions in mind it was told that no further announcement of the extra task would be given later on. Intentions were provided for three of the six different goals and hence, the means associated to these three goals were the test means and the means associated to the remaining three goals were the control means. Different sets were created that varied the function of the means as either test or control means. These set were counterbalanced between participants. As a result of the intention instructions, four different types of means were created: the habitual and the non-habitual means associated to the test goals and the habitual and non-habitual means associated to the control goals.

In the subsequent task, accessibility of the different means was assessed with a means-recognition task in which participants had to indicate as fast and as accurately as possible whether the presented word was a means or not that they generated earlier in the experiment for one the goals (see also Danner et al., 2007a). The faster participants were able to recognize the means, the more accessible the means were. In total, 24 words were presented: the 12 idiosyncratically generated means provided the yes-answers and 12 other words, not presented before, provided the no-answers. All words were presented randomly, preceded by two warming-up trials. To keep up with the cover story, after the accessibility measure participants were provided with the extra task in which they questioned about their habitual or the non-habitual means for the goals. Finally, some demographics were assessed and participants were paid and thanked for their participation.

Results

Incorrect recognition responses (nearly 10 % of the trials), as well as reaction latencies higher than three standard deviations above the mean (nearly 1 % of the trials), were excluded from the analyses. The response latencies were subjected to a 2 x 2 x 2 mixed model analyses of variance (ANOVA) with intention condition as the between-participants factor (intentions on habitual means versus intentions on non-habitual means) and with accessibility of means (habitual versus non-habitual) and type of means (test means versus control means) as the within-participants factors.

A main effect was found of type of means, $F(1, 115) = 16.41$, $p < .001$; participants were faster to recognize the means associated to the goals on which intentions were formed than associated to the control goals). Furthermore, an interaction effect for intention condition x accessibility of the means was found, $F(1, 115) = 11.35$, $p = .001$. More importantly, the analysis yielded the a three-way interaction effect, $F(1, 115) = 43.44$, $p < .001$. To interpret this interaction effect and to test our specific hypotheses, simple comparison analyses were conducted. We will report the findings for each intention condition separately[2].

In both conditions we expected that the means on which intentions were formed, were more accessible and therefore faster recognized than the means for the goals on which no intentions were formed (the control means). However, we hypothesized that access to non-habitual means will not be reduced as a result of intentions on the habitual means for the same goal, while we did assume to find inhibition of the habitual means when intentions were formed on the non-habitual means for the same goal. To illustrate these facilitation and inhibition effects, Figure 3.1 presents the response latency difference scores between the habitual control and habitual test means on the

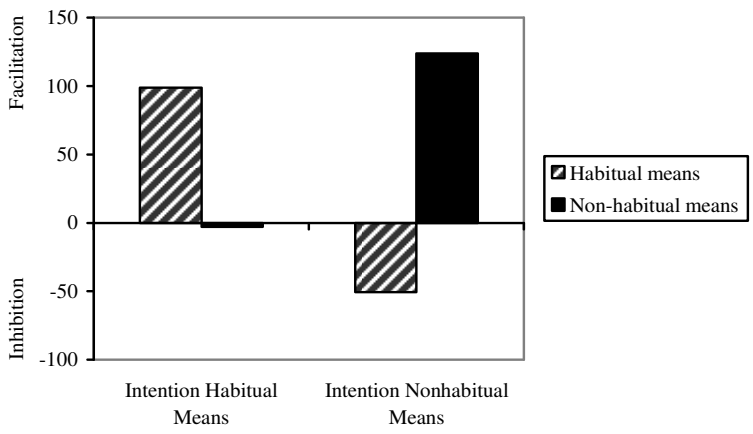

Figure 3.1. Mean difference scores in response latency (ms) between the control and experimental habitual means and between the control and experimental non-habitual means per intention condition. A positive score indicates facilitation and a negative score indicates inhibition.

one hand and between the non-habitual control and non-habitual test means on the other for the two intention-conditions separately.

Intention to use habitual means condition. The results (see Figure 3.1) showed that participants were faster to recognize the habitual means on which intentions were formed than the habitual means on which no intentions were formed, $F(1, 116) = 23.47$, $p < .001$. No effects were found for the non-habitual means related to the test goals in comparison to the control goals; the non-habitual means related to the habitual intentions were not faster or slower recognized than the non-habitual means related to the control goals, $F(1, 116) = 0.01$, *ns*.

Intention to use non-habitual means condition. The non-habitual means (see again Figure 3.1) on which intentions were formed were recognized faster than the non-habitual means on which no intentions were formed, $F(1, 116) = 32.56$, $p < .001$. More importantly, the habitual means related to the test goals were recognized slower than the habitual means related to the control goals, $F(1, 116) = 4.55$, $p = .035$; an inhibition effect. The habitual means that were

related to the non-habitual intentions were inhibited upon the formation of the intention.

General Discussion

The main aim of the current research was to examine the potential interference of habitual goal-directed means when an intention is formed to utilize a non-habitual means for goal attainment. By using idiosyncratic goal-means relations, the first study showed that the mental representation of habitual means was readily accessible upon goal priming compared to the non-habitual means and that these differences in spontaneous activation were attributed to differences in frequency of using the means. These findings extend previous work on the accessibility of goal-directed habits (Aarts & Dijksterhuis, 2000a; Sheeran et al., 2005), and importantly, they show that habitual means may interfere with, and form a potential threat for intentions to use non-habitual (alternative) means to attain the same goal. Accordingly, the results of the second study revealed that the formation of intentions to pursue the goal with the non-habitual means caused the habitual means to be inhibited. However, intentions to attain the goal in the habitual way did not cause inhibited access to the alternatives. Together, then, our data provide clear evidence for the notion that the intention to use alternatives are shielded against the interference of habitual means to attain goals by inhibiting the mental representation of these habitual means.

The present findings provide evidence that inhibitory processes are not only necessary to shield intentions from merely semantically related information (Veling & Van Knippenberg, 2006), but also guide goal-directed intentions in a context with multiple means. Goal attainment can be rather efficient in the sense that people are able to enact their goals habitually, i.e. independent of intentional control or explicit expectancies (Bargh, 1990a; Moskowitz et al., 2004). The drawback is that the representation of the habitual behavior will be activated more easily by the goal than a non-habitual behavior representation when an intention is formed to realize the goal in a different way. Our data

show that inhibitory processes can protect this goal-directed intention by controlling potential interference arising from the automatic activation of the habitual means

Whereas our data show that intentions to use non-habitual means inhibit access to the habitual means, this effect did not seem to hold the other way around, i.e. when participants formed the intention to use their habitual means, no inhibition of the non-habitual means occurred. This finding suggests that non-habitual means do not interfere with the intention to use habits. However, inhibition has been found to regulate the initiation of habit formation in a multiple means context. In a recent set of studies we established that inhibitory processes are necessary to guide an efficient memory retrieval of means to attain goals, and that this inhibition during the early stages of habit formation required practice (Danner et al., 2007a; cf. Shah et al., 2002). However, it is important to note that these inhibition effects of alternative (non-habitual) means occurred after nine practice trials, and therefore, we were unable to draw conclusions about the role of inhibition in a more advanced stage of the habit formation process. The present findings indicate that the inhibition of (non-habitual) alternatives dwindles, basically because these alternatives are less likely to be readily activated upon priming the goal (see Study 3.1), and hence, these means lose their functionality as alternatives in the selection process when habits are established (see also Aarts et al., 1998).

Our findings indicate that inhibitory control occurs to cognitively regulate intentions to deviate from habitual goal pursuit. As research on intention, cognition and action suggests (Einstein & McDaniel, 2005; Kuhl, 1987), the enactment of intentions in everyday life involves at least two distinct memory processes. First, an intention has to be formed or encoded into to the proper mental representation or content of the intended behavior and secondly, it often has to be maintained in memory. Inhibitory control of the habitual behavior representation when people are concerned with intentions to use non-habitual means, then, might play an important role in both of these processes (Beckmann, 1998; Marsh et al., 1998; Veling & Van Knippenberg, 2006). That

is, inhibitory processes eases the encoding of the intention; when access to the habitual means is inhibited, it should be easier to form the intention to use a non-habitual means for goal pursuit. Inhibition, however, can also play a role in shielding the maintenance of the intention. To have the intention readily available in memory, the representation of the non-habitual goal-directed behavior has to sustain accessible or active. However, as the goal is part of this mental representation and, at the same time, is associated with the habitual means, it will also trigger direct access to the habitual means. Consequently, the habit will potentially distract the non-habitual behavior representation and can cause the intention to be forgotten. In the present study, we asked participants to form intentions to use non-habitual means and to keep them in mind for later use, hence, to encode and maintain intentions. Accordingly, shielding these intentions from the intrusion of habitual means might have occurred during one or both of these processes.

The present studies suggest that successful alteration of habits is possible through inhibitory control by shielding the intention from distraction of habits. However, as promising as these results may be, things may be less perfect in everyday life. There are several important pitfalls that may prevent the intention to use non-habitual means from actual implementation. We discuss two of such difficulties here. First, although inhibitory control is very useful to act on intentions to use non-habitual means, it also implicates that (additional) cognitive effort is required to shield the intentions from the distracting. This idea derives from models of executive control and nonconscious goal pursuit (see also Aarts, 2007) that state that engaging in goal pursuit requires mental resources. Although people are not necessarily aware of this (Hassin, Aarts, Eitam, & Custers, 2006), their performance on a subsequent task is reduced as not enough resources are available. Shah and colleagues (Shah et al., 2002) found that the extent to which people inhibit competing goals upon the activation of a focal goal is positively related to goal achievement. However, further experimentation revealed that this inhibition effect may draw resources away from the focal goal (Shah & Kruglanski, 2002) suggesting that the

inhibitory processes to shield goal pursuit consumes mental resources and is thus effortful.

In a study on the differences of suppressing habitual and non-habitual means upon goal priming, Aarts and Dijksterhuis (2000b) showed that habitual means are harder to suppress than non-habitual means, and importantly, that the suppression of habitual means was especially difficult when attentional resources were absorbed by a secondary task. In other words, in cases where one cannot rely on inhibitory control processes (e.g. due to cognitive load by other goals or tasks taxing working memory processes; see Engle, 2002; McCabe, Robertson, & Smith, 2005), it may be difficult to deviate from habits, even though an explicit intention to do so is formed. Future research could shed more light on this important issue by examining how the formation versus maintenance of intentions is impaired by cognitive load when habits do interfere.

A second difficulty concerns the role of the context or environment in which habitual goal-directed behavior is directly triggered and performed. Research on attitude-behavior models suggests that goal-directed habits automatically materialize in the presence of the environment in which the habits have been frequently and consistently performed in the past. In other words, a stable context renders habitual behavior to emerge directly, without involvement of intentional processes (Danner et al., in press; Ouellette & Wood, 1998; Wood et al., 2005). According to this notion, the intention to use non-habitual means may inhibit the accessibility of habitual means (as was demonstrated in Study 3.2), but the later exposure of the habitual situation may reactivate the habitual goal-directed behavior, thus overruling one's intention to deviate from the habit. In that case, the enactment of intentions does not fail because of the inability to shield them from habits upon forming and maintaining the intentions, but because the environmental link with the habit was not taken into account when forming the intention. Indeed, recent work suggests that intentions that anticipate such environmental features (also known as implementation intentions; Gollwitzer, 1999; Goschke & Kuhl, 1993) may be an

effective regulatory tool to break and even create new goal-directed habits (Holland et al., 2006).

To conclude, people often plan the execution of their goals. When they intend to pursue a goal different from their routinized way of goal attainment, people may shield their intentions by inhibiting their habits from kicking in rapidly and easily. As long as inhibition can be effectively exerted, habit change could be successfully accomplished. However, as we discussed above, we should be cautious about this enterprise. The simultaneous performance of other tasks in the habitual situation at issue might impair the enactment of intentions and thus hamper the occurrence of habit change. So in order to have the intended salad for lunch, it is necessary to inhibit thoughts about a hamburger until one actually has ones lunch in ones hands.

[1] The response latencies on the habitual and non-habitual means were averaged between the goals (resulting in one habitual and one non-habitual latency). Separate analyses for each goal showed similar results as the combined analysis and are therefore not reported.

[2] ANOVA on the recognition accuracy scores showed that participants' accuracy scores were higher for intention means in each condition than for the related alternative means or the control means. However, because controlling for these differences in the ANOVA, with the response latencies as dependent variable, did not change the reported pattern of results, they are not further reported in the analyses.

Chapter 4

Habit versus intention in the prediction of future behavior: The role of frequency, context stability and mental accessibility of past behavior

This chapter is based on Danner, U.N., Aarts, H., & De Vries, N.K. (in press). Habit versus intention in the prediction of future behavior: The role of frequency, context stability and mental accessibility of past behavior. *British Journal of Social Psychology.*

People are creatures of habit. Many of their everyday goal-directed behaviors 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 behavior 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 behavior causes the mental representation of the behavior to be directly elicited when encountering the given context (Aarts & Dijksterhuis, 2000a; Bargh, 1990). Accordingly, conscious effort to plan and initiate goal-directed behavior becomes redundant. That is, people are able to perform goal-directed behavior without forming an explicit intention because the behavior is directly mentally accessed in the context at hand as a result of frequently and consistently having performed that behavior in the past.

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

An important contribution in the field of habits and attitude-behavior 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 behavior in the past) does predict future behavior over and above intentions, suggesting that such behavior 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 behavioral 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 behavior on future behavior also underscores the behaviorists' maxim that behavior is largely influenced by habit. However, the direct relation between past and future action is not really informative in understanding when goal-directed behavior is best predicted by habits or by 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 behavior, Triandis (1980) proposed a model suggesting that habit and intention *interact* in their prediction of later behavior – in stead of predicting behavior over and above a measure of intention. In fact, Triandis hypothesized that when the same behavior is more frequently executed in the past and increases in habit strength, it is less guided by intention to perform that behavior. In this sense, habits are automatic to the extent that the behavior is no longer predicted (or guided) by intentions. Habit strength thus may moderate the relationship between reason-based concepts (intentions) and subsequent goal-directed behavior (see also, Ronis et al., 1989). The stronger the habit, the weaker the intention-behavior relationship.

Whereas the moderating role of habits in the intention-behavior relationship offers a promising perspective on testing the habitual nature of goal-directed behavior, 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 (1991) examined women's behavior 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 behavior 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 behavior on their intention than women with fewer previous mammograms.

However, it has been argued that past behavior frequency may not represent the most optimal measure to examine how habit strength moderates the relation between intention and behavior (Ouellette & Wood, 1998; Verplanken & Aarts, 1999). In a different attempt to study the role of habits in goal-directed behavior, Aarts and colleagues developed the Response Frequency measure which they tested in the realm of travel mode behavior, a behavior 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 behavior. 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 behavior: when habit was strong intention did not predict future behavior, whereas behavior was predicted by intentions when habit was weak. Taken together, then, these results showed that the decision making process underlying goal-directed behavior ceases to exist when habits grow in strength. Or in other words, more practice leads people to initiate goal-directed behavior without much thought and consideration.

The role of context stability

Whereas the studies alluded to above suggest that control of goal-directed behavior shifts from an intentional to a more habitual (nonintentional) process when the behavior 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 behavior (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 (that is, place, time and situation) in which the behavior 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 behavior; 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 behavior 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 behavior 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 behavior and hence, the context is capable of eliciting the performance of the behavior 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 behavior in the same context, or regularly perform the same behavior in different contexts, as the context is either less strongly or less uniquely linked to the behavior. For example, a person drinking white wine sporadically during the past four 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

behavior 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 behavior in a habitual way is a multiplicative function of the frequency of past behavior in a period of time and context stability of the behavior.

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 behavior is performed both *frequently* and in a *stable context*. This line of argumentation suggests that a measure of frequency of past behavior is more likely to moderate the intention-behavior relationship when the stability aspect is taken into account. In testing this idea for several mundane behaviors (such as watching TV or reading a newspaper), Wood and colleagues estimated habit strength by multiplying a measure of past behavior frequency with a measure of context stability (that is, the extent to which the behavior 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 behavior. Although Wood and colleagues did not directly compare the effects of their habit scale with the traditional habit measure of past behavior 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 behavior.

Present research

In an attempt to extend previous work, the present research tested the moderating role of habit in the intention to future behavior link by considering

the stability of the context in which past behavior 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 behavior frequency would not moderate the intention-behavior 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 behavior frequency, context stability and intention. Subsequently, respondents were revisited four weeks later and their actual behavior was assessed. This allowed us to test and compare the moderating role of the measure of past behavior frequency with the habit scale in the intention-behavior 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 behavior 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 behavior (i.e., the ease of accessing the goal-directed behavior in memory) in moderating the intention-behavior relation. If habitual behavior is directly activated by the context, mental accessibility of the behavior should moderate the relation between intention and future behavior: intention will only predict behavior when the accessibility of the representation of the habitual goal-directed behavior is low and not when the accessibility is high (see also Aarts & Dijksterhuis, 2000a, 2000b).

Study 4.1

In the first study we assessed participants' frequency and context stability of past behavior and, conform Wood et al. (2005), we combined these two factors into an index of habit strength. Intention, past behavior frequency and context stability were measured for three different behaviors: snacking, drinking milk and drinking alcohol. Four weeks later, participants were asked to indicate how often they actually had performed the behavior 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 behavior 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 behavior, while such interactive pattern is less likely to emerge when merely the measure of frequency of past behavior is used. To examine whether the potential interaction effect between habit strength and intention is the result of a combined effect of past behavior frequency and context stability (i.e., behavior 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 behavior as well.

Method

Participants and design. Hundred 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 behavior and context stability of three everyday goal-directed behaviors: snacking, drinking milk and drinking alcohol) took place four weeks before the second measurement (in which the behaviors 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 behaviors. For each behavior participants were asked to indicate their *intention* to perform the behavior in the next four weeks on a nine-point scale ranging from 1 "no, not at all" to 9 "yes, certainly". Furthermore, *frequency of behavior* in the past four weeks was assessed by asking respondents to indicate how often they performed each behavior on a nine-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 behavior was carried out. Participants were told that if these three aspects always differed, i.e. the behavior was executed in different places, at different times and in different situations, the context in which past behavior was executed was unstable. However, when these three aspects are similar each time the goal-directed behavior is performed, then the context is stable. Between these two endpoints stability may differ to the extent that each aspect is the same or not when performing the behavior (see also Wood et al., 2005). Stability of the context in which the behavior was performed was assessed on a nine-point scale ranging from 1 "unstable" to 9 "stable". For each specific behavior, a habit strength scale was calculated by multiplying past behavior frequency with context stability in which the past behavior 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' email-address 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 behavior in the four 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 behaviors as in the first measurement. Participants were asked to indicate how often they had performed the behavior in the past four weeks on a nine-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 behavior frequency and context stability with the habit strength scale in moderating the prediction of future

Table 4.1a

Correlations between behavior four weeks later and past behavior, context stability and intentions (N =139).

Snacking	Future Behavior	Intentions	Past Behavior	Context Stability
Future Behavior	___	.46	.57	.31
Intentions		___	.63	.39
Past Behavior			___	.32
Context Stability				___
Drinking Milk	Future Behavior	Intentions	Past Behavior	Context Stability
Future Behavior	___	.80	.84	.60
Intentions		___	.90	.65
Past Behavior			___	.66
Context Stability				___
Drinking Alcohol	Future Behavior	Intentions	Past Behavior	Context Stability
Future Behavior	___	.65	.75	.45
Intentions		___	.77	.60
Past Behavior			___	.58
Context Stability				___

Note. All correlations, $p < .001$

behavior by intention, three separate regression analyses were conducted per behavior. 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 behavior, context stability or habit strength in the prediction of later behavior. For each behavior, intention and either past behavior, context stability or habit strength were entered in Step 1, and the interaction of intention by past behavior, context stability or by habit strength was entered in Step 2. The correlations between future behavior, intention, past behavior and context

Table 4.1b

Hierarchical Regression Analysis predicting behavior four weeks later from past behavior and intentions to perform the behaviors (Past Behavior), context stability and intentions to perform the behaviors (Context Stability), and habit strength and intentions to perform the behaviors (Habit Strength) for each behavior separately (N =139).

	Snacking			Drinking Milk			Drinking Alcohol		
	β	**t**	**p**	**β**	**t**	**p**	**β**	**t**	**p**
Past Behavior									
Intentions	.16	1.78	.078	.21	2.00	.053	.18	2.07	.040
Past behavior	.47	5.29	< .001	.65	6.16	< .001	.61	7.04	< .001
Intentions x Past Behavior	-.11	-1.43	ns	-.05	-0.75	ns	.014	0.13	ns
Context Stability									
Intentions	.40	4.83	< .001	.70	10.49	< .001	.59	7.29	< .001
Context Stability	.15	1.89	.07	.14	2.12	.04	.10	1.18	ns
Intentions x Context Stability	.001	0.02	ns	.06	1.22	ns	.05	0.50	ns
Habit Strength									
Intentions	.16	1.73	.086	.51	6.43	< .001	.45	5.71	< .001
Habit Strength	.48	5.34	< .001	.35	4.43	< .001	.32	4.03	< .001
Intentions x Habit Strength	-.22	-2.30	.023	-.23	-2.27	.025	-.15	-1.12	.26

stability are presented in Table 4.1a and the results of the three analyses (the frequency of past behavior and context stability measures versus the habit strength scale) are presented in Table 4.1b (referred to as Past Behavior, Context Stability and Habit strength respectively). Below, we present the results of these analyses for each behavior separately.

Snacking. A strong main effect of past behavior frequency was found as well as a smaller effect of intention. No interaction effect was found between past behavior frequency and intention to perform the behavior. Both factors were predictive of later behavior, but did not interact in the prediction of later behavior. Similar effects were found for stability of the context and intention to perform the behavior indicating that both factors were predictive of later behavior, but did not interact. Habit strength and intentions were also both related to later behavior. 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 behavior for participants with relatively stronger and weaker snacking habits (see also Figure 4.1a). The analysis showed that the slope for intention-behavior relation was significant and positive when snacking habit was weak, $b = .29$, $p = .007$, while the slope was non-significant when snacking habit was strong, $b = -.13$, *ns*.

Drinking milk. The analyses for the act of drinking milk showed that frequency of past behavior and intention were both related to later behavior, but did not interact. Stability of the context and intention to perform the behavior were also both predictive of later behavior, 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 behavior when the milk habit was weak, $b = .59$, $p < .001$, but was not related when the milk habit was strong, $b = -.005$, *ns* (see also Figure 4.1b).

Drinking alcohol. Frequency of past behavior 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 behavior and again, no interaction was found. Habit strength and intention were both related to later behavior. 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 = .42, p < .001 and was non-significant when it was a strong habit, b = .16, *ns*, see also Figure 4.1c.

Taken together, the findings of the first study indicate that measures of frequency of past behavior, context stability, habit strength and intention were all predictors of the three single behaviors under investigation (albeit that the weight of the components differed across the behaviors). Importantly, the frequency or the context stability measures alone did not interact with the intention in the prediction of behavior, showing that frequency of past behavior and context stability separately were no optimal measures to disentangle the habitual and intentional control of behavior. However, further analyses revealed that frequency of past behavior moderated the intention-behavior 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-behavior 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].

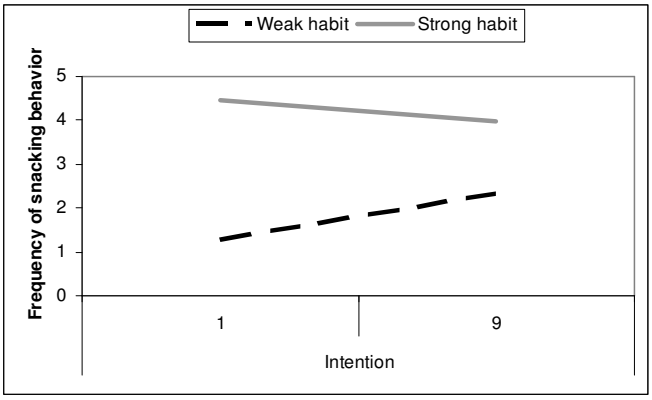

Figure 4.1a. Decomposition of two-way interaction: Frequency of snacking behavior over four weeks as a function of intentions to perform the behavior and snacking habit strength.

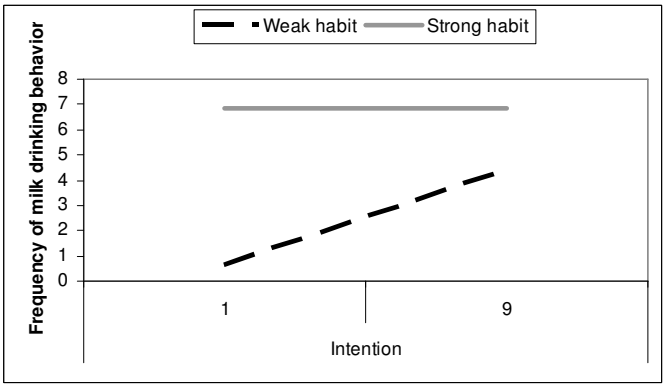

Figure 4.1b. Decomposition of two-way interaction: Frequency of drinking milk behavior over four weeks as a function of intentions to perform the behavior and milk drinking habit strength.

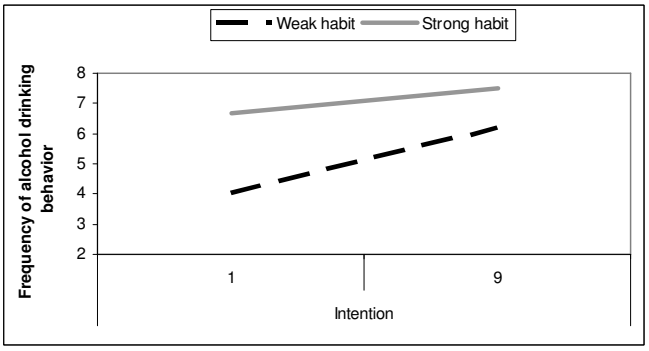

Figure 4.1c. Decomposition of two-way interaction: Frequency of drinking alcohol over four weeks as a function of intentions to perform the behavior and alcohol drinking habit strength.

Study 4.2

The purpose of the second study was to replicate and extend the findings of Study 4.1 to another behavioral domain: travel behavior. Earlier studies have shown that habits play a prominent role in travel behavior (Aarts et al., 1997b, 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 behavior and the Response Frequency measure. These measures have been shown to predict transport-mode choice behavior over and above intentions. More importantly, Verplanken et al. showed that their Response Frequency measure and frequency of past behavior both interacted with a measure of intention in the prediction of future behavior. However, the behavior 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 behavior may have represented an optimal measure of habit strength, and hence, this measure interacted with intention in the prediction of future travel behavior.

In Study 4.2 we also examine travel behavior but here we focus on cycling behavior among students for several travel goals in a Dutch town. It is likely that for some students this behavior 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 4.1, we assume that only those students who have cycled frequently in a stable context during the past four weeks will have developed a strong cycle habit. To test this idea, we examined in Study 4.2 cycling behavior to various short-distance destinations. For each destination, intention, past behavior frequency and context stability towards bicycle use were measured. Four weeks later 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 4.1: the frequency of past behavior measure will predict future behavior over and above intention, while the habit strength scale will interact with intention in the prediction of behavior. In line with the findings of Study 4.1, the frequency and context stability measures alone are not expected to show an interaction effect with intention in the prediction of future behavior.

Method

Participants and design. Eighty students (61 females and 19 males) of Utrecht University participated in exchange for €5. Because bicycle travel behavior 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 had a longitudinal design with two measurements. The first measurement (assessing intention, frequency of past behavior and context stability as to cycling behavior to various destinations in Utrecht) took place four 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 were going to fill out a survey that aimed to investigate travel behavior 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., a means instrumental for attainment of the goal). The survey consisted of questions concerning cycling behavior to different travel locations: their *past behavior*, the *stability of the context* in which the behavior was executed and their *intention* to perform the behavior in the next four weeks (see also Study 4.1). 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 four weeks. The remaining variables were both measured on a nine-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 email-address and their phone number to contact them for the next measurement.

Measurement Two. The second measurement was conducted to measure actual cycling behavior in the four 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 nine-point scale ranging from 0 "not at all" to 8 "very often".

Results and discussion

Habits strength was again construed by multiplying past behavior frequency with context stability (a high score indicates a strong habit) for each destination separately. As cycling behavior to several destinations was measured, we calculated Cronbach's alpha for the measures of intention to cycle, frequency of past cycling behavior, stability of the context in which past behavior was executed, strength of cycling habit and future behavior to ensure that we measured generalized cycling behavior 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 behavior frequency and context stability measure with the habit scale measure in moderating the prediction of future behavior by intention. In the first analysis frequency of past behavior 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 behavior, 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 4.2a and the results

Table 4.2a

Correlations between cycling behavior four weeks later and past behavior, context stability and intentions (N =80).

	Future Behavior	Intentions	Past Behavior	Context Stability
Future Behavior	___	.58**	.59**	.26*
Intentions		___	.62**	.49**
Past Behavior			___	.42**
Context Stability				___

Note. * p < .05 and ** p < .001

of the analyses are presented in Table 4.2b. Frequency of past behavior and intention to cycle were both related to later behavior. In the second analysis it was found that context stability was not predictive of later behavior while intentions were related. However, these factors – that is, frequency of past behavior and intention as well as context stability and intention – did not interact in their prediction of later behavior. Hence, these results suggest that people cycle more when they have done so repeatedly before and when their intention to cycle is stronger.

Table 4.2b

Hierarchical Regression Analysis predicting cycling behavior four weeks later from intentions and past behaviour frequency, context stability, and habit strength (N =80).

Variable	β	t	p
Intentions	.25	2.41	.019
Past behavior	.54	5.27	< .001
Intentions x Past Behavior	-.09	-.89	ns
Intentions	.59	5.55	< .001
Context Stability	-.03	-0.27	ns
Intentions x Context Stability	-.01	-0.12	ns
Intentions	.35	3.37	.001
Habit strength	.40	3.91	< .001
Intentions x Habit strength	-.24	-1.98	.05

The significant main effect of habit and intention (third analysis) showed that both factors were positively related to later behavior. More importantly, the interaction between habit and intention was significant. In concurrence with Study 4.1, 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 behavior and intention to cycle for participants with stronger and with weaker habits, see also Figure 4.2. The analyses showed that the slope of the regression line for later behavior was positive when habit was weak, $b = .44$, $p < .001$. However, the regression slopes were non-significant when habit was strong, $b = -.14$, *ns*. Hence, intentions were not indicative of later behavior when the habit was strong, or in other words later behavior was related to intentions when the cycling habit was weak[2].

The results of Study 4.2, then, replicate and extend those of Study 4.1. First, we demonstrated that a frequency measure of past behavior and a context stability measure separately did not moderate the intention-behavior relation. However, we showed that this interaction effect emerged when

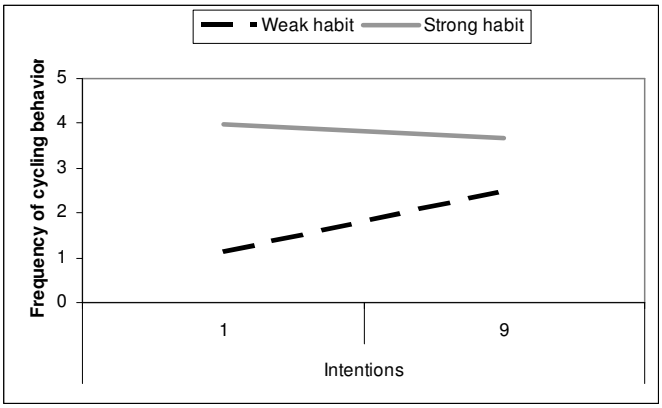

Figure 4.2. Decomposition of two-way interaction: Frequency of past cycling behavior to various travel locations as a function of intentions to perform the behavior and habit strength to cycle to the various locations.

information about the stability of performing the behavior was directly combined with the frequency of past behavior into the habit index proposed by Wood et al. (2005). Furthermore, we established this effect for another type of goal-directed behavior – travel mode choice behavior – that has been previously shown to be guided by habits.

Study 4.3

So far, the findings of two studies indicate that intentions do not predict goal-directed behavior when the behavior 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 behavior. Specifically, our results suggest that the mental representation of the goal-directed behavior is directly triggered by the context when that behavior is frequently and consistently performed in that context and, as a consequence, guides behavior in the context at hand without the mediation of intention. This notion concurs with recent evidence obtained in the area on automatic goal-directed behavior (Bargh & Chartrand, 1999; Custers & Aarts, 2005; Moskowitz et al., 2004). Most research in this field is based on Bargh's auto-motive model (Bargh, 1990a) 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 behavior in the same environment. As Bargh and Chartrand (1999) note: "Initially, conscious choice and guidance are needed to perform the desired behavior … 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 behavior is conditional on forming explicit intentions to the extent that the behavior can be directly mentally accessed as a result of frequently and consistently having performed that behavior in the past.

Study 4.3 aimed to explore an important hypothesis that can be derived from this proposition. Specifically, we tested whether the mental accessibility of the goal-directed behavior (or the ease of accessing the representation of the

behavior in memory) moderates the intention-behavior relationship. Based on the auto-motive model of habitually performed goal-directed behaviors, we hypothesized that intentions do not predict later behavior when the behavior is highly accessible, while the behavior 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 behavior and investigated the interaction between these two measures in the prediction of future cycling behavior. Accessibility was measured with a response latency task, modeled 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 behavior (in this case, of cycling behavior).

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 had a longitudinal design. The first measurement (assessing accessibility and intentions as to cycling behavior to various destinations in Utrecht) took place four weeks prior to the second measurement (in which the same cycling behaviors 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 nine-point scale. In addition, we measured the accessibility of cycling behavior 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 traveling. Similar to Study 4.2, 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 behavior. 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 intertrial time was 1 sec. The accessibility measure was operationalized as the speed of responding with "yes" to the six critical location-bicycle combinations (98.1 % out 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' email-address and phone number were collected to contact them for the second measurement.

Measurement Two. The second measurement was conducted four weeks after the first measurement. Participants were asked to indicate the frequency of their bicycle behavior to the various locations in the past four weeks by typing in the number of times they performed the behavior. 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 behavior to several different destinations was measured, we

Table 4.3a

Correlations between cycling behavior four weeks later, accessibility and intentions (N = 65).

	Future Behavior	Intentions	Accessibility
Future Behavior	___	.29*	.00
Intentions		___	.09
Accessibility			___

Note. * p < .05

calculated Cronbach's alphas for the measures of intention, mental accessibility and future behavior. 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 behavior; 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 4.3a. The results (presented in Table 4.3b) show that intention was positively related to later behavior. More important, the interaction between intentions to cycle and accessibility of the mental representations of cycling behavior approached significance, $b = .25$, $p = .06$.

To gain further insight in this interaction and to test our specific hypothesis, we conducted simple regression analyses by calculating simple slopes for

Table 4.3b

Hierarchical Regression Analysis predicting cycling behavior four weeks later from intentions to perform the behavior and accessibility of cycling behavior to various locations (N = 65).

Variable	β	t	p
Intentions	.29	2.36	.022
Accessibility	-.024	-0.20	ns
Intentions x Accessibility	.25	1.87	.066

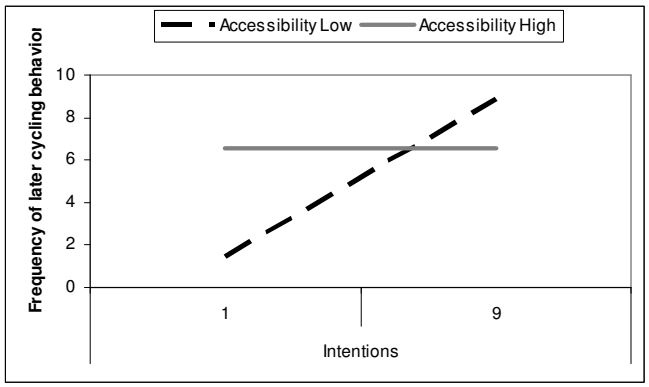

Figure 4.3. Decomposition of two-way interaction: Frequency of cycling behavior over four weeks as a function of intentions to perform the behavior and accessibility of cycling behavior to various locations.

intention at varying levels of accessibility (in accordance with Study 4.1 and 4.2). 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 behavior for high and low accessibility of the mental representations of cycling. Figure 4.3 presents the regression lines for the interaction effect of intention by accessibility on later behavior. Simple slope analyses showed that intention was positive related to later behavior when accessibility was low, b = .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 behavior when the mental accessibility of the behavior was low, while the behavior was not related to intention when the accessibility was high.

General Discussion

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

shown that measures of past behavior frequency predict future behavior over and above intentions. The findings of the present studies indicate that frequency of past behavior does not necessarily result in habitually driven behavior. Specifically, we demonstrated that frequency of past behavior moderated the intention-behavior relations only when information about the stability of the context in which the behavior has been performed is represented in a habit measure: intentions do not guide behavior when it is frequently performed in a stable context (i.e., strong habit), while intentions are more likely to guide behavior 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 behavior is performed plays a crucial role in the establishment of habits: Behavior 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 behavior is executed always differs instigation of the behavior is dependent on intentions. Similarly, although behavior is always performed in the same context, intentional processes will still guide behavior when performance of the behavior 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 behavior. Moreover, our studies extend previous work that addresses (either implicitly or explicitly) the importance of the context of behavior in understanding the role of habits in intention-behavior 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 behavior. 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

behavior 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 behaviors in Study 4.1 and Study 4.2 (showing the important 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 4.3 explored the idea that goal-directed behavior is no longer guided by intentions when the representation of the behavior 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 behavior. Actual bicycle behavior was not predicted by intentions to use the bicycle for participants who readily accessed representations of bicycle use in memory. However, intentions predicted behavior 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 behavior is less accessible. These findings support the idea that goal-directed behavior 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 behavior in the same context. In another recent line of research, Danner, Aarts and De Vries (2007b) showed that the mental accessibility of goal-directed behavior 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 behavior, our findings suggest that habitual behavior is triggered in the presence of a stable context without the mediation of intentions because people directly access and act on the behavior representation to guide their behavior.

Furthermore, the present research speaks 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 behavior 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 behavior (in this case, transport mode behavior) is not predicted by the intention to perform the behavior when the representation of the behavior (or goal-mean link) is readily activated by the behavioral (travel) context at hand. Given the present evidence of the role of mental accessibility of representations of goal-directed behavior in predicting habitually driven behavior, 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 behaviors (Aarts & Dijksterhuis, 2000a; Danner, Aarts, & De Vries, 2007a).

The present research may also add to the debate about how habits should be operationalized in research on attitude-behavior 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 behavior "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 behavior operate unconsciously (Nisbett & Wilson, 1977; see also Verplanken & Aarts, 1999), these measures attempt to tap into unique

aspects of habits (cf. Verplanken et al., 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 behavior. Specifically, our findings indicate that the more easy one can access the mental representation of behavior in memory, the less likely the behavior is guided by conscious intent. Therefore, assessing the mental accessibility of goal-directed behavior may provide additional information about the extent to which the behavior 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 behaviorist tradition (e.g., Hull, 1943; Skinner, 1953), frequency of past behavior is the most recognized method but, as the present data show, such a measure may not tap the actual essence of habitual goal-directed behavior (Ajzen, 2002; Mittal, 1988; Verplanken et al., 2005; Wood et al., 2005). As Mittal (1988) 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. (2005), a measure of habit should incorporate information about (self-reported) frequency as well as stability of the context of behavior. Specifically, future behavior is less predicted by intentions to the extent that people perform the behavior 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 behavior.

[1] A hierarchical regression analysis was also conducted to test the contribution of the three-way interaction between frequency of past behavior, context stability and intention in the prediction of later behavior for each behavior separately. These analyses provided the following contributions of the three-way interaction: for snacking, $\beta = .095$, $t = 0.77$, *ns*; for drinking milk $\beta = -.59$, $t = -3.26$, $p = .001$; and for drinking alcohol, $\beta = -.062$, $t = -0.25$, *ns*.

[2] Similar to Study 1, we also conducted a hierarchical regression analysis to test the three-way interaction between frequency of past behavior, context stability and intention in the prediction of later cycling behavior. This analysis yielded the following result for the three-way interaction: $\beta = -.36$, $t = -2.00$, $p = .050$.

Chapter 5

General discussion

Research in the past two decades has provided strong evidence that goal pursuit can occur without involvement of conscious intent. That is, automatic processes guide the instigation and performance of goal-directed behaviors. In the present thesis I have focused on a special form of automatic goal pursuit, namely habits. Habits, as conceptualized in the present work, are special in the sense that intentional processes initially regulated the goal-directed behaviors but through the frequent and consistent performance of these behaviors in the same context, habits are established. I have focused on the cognitive mechanisms underlying the formation and maintenance of habits and on the interplay between intentions and habits in controlling goal-directed behavior.

In Chapter 2, I have investigated how the formation of goal-directed habits can occur in a context where alternative means are also available for goal pursuit. More specifically, I examined how a specific means is selected while the other, alternative means seem to be forgotten. Using a memory retrieval paradigm in which the frequency of retrieving a target means was varied, simulated the process of habit formation. It was found that repeated retrieval of the target means resulted in inhibited access to these alternatives. This finding implies that in order to ease the search and retrieval of a previously selected means from memory (in other words, to instigate habit formation) interfering alternative means have to be inhibited. Moreover, as was also suggested by others (e.g., Dijksterhuis & Van Knippenberg, 1998; Levy & Anderson, 2002) this inhibitory process emerges without conscious intent to suppress the alternative means. So by inhibitory processes goal pursuit can occur more easily in a context where alternative means are available and, hence, the need for intentional processes to choose between these means is reduced.

In Chapter 3, I examined how it is possible to act upon intentions to use non-habitual means for goal attainment when habits have been established, i.e. how people can have intentions in memory to perform non-habitual goal-directed behavior. Once habits are established it may be expected that the goal will facilitate access to the habitual means and, hence, will hinder these intentions to perform non-habitual behavior. It was indeed found that means

that are habitually, i.e. more frequently, used for realization of the goal are more easily accessed after exposure to this goal than non-habitual means. This is in agreement with earlier work on the mental mechanism underlying goal-directed habits (Aarts & Dijksterhuis, 2000a; Sheeran et al., 2005). Because the habitual means are more easily accessed, it is likely that these means will interfere with the intentions to use non-habitual means. To prevent habitual intrusion, the habitual means have to be inhibited in order to have the intention in memory to perform non-habitual behavior. Although past research has focused mainly on the failure of these intentions (see research on action slips, e.g., Heckhausen & Beckmann, 1990), the findings in the current research suggest that people can overcome these intrusions; inhibitory processes can facilitate the process of habit change.

Whereas the findings of Study 3.1 and 3.2 show that intentions to counteract habits may control habits, I examined in Chapter 4 whether intentions predict future behavior, and how frequency and context stability (two indicators of habit strength) moderate this prediction. The results showed that intentions did no longer predict future behavior when the behavior was performed repeatedly under the same circumstances (i.e., strong habits), whereas intention influenced behavior when the behavior was carried out less frequently or always under different circumstances (i.e., weak habits). This interaction between habits and intentions only emerged when the measure to assess habit strength considered both factors: past performance frequency and stability of the context in which past performance was executed. So habits will only emerge and influence later behavior directly when the behavior is repeatedly performed in a stable context. Consequently, intentional processes are no longer controlling the behavior as the mental representation of the goal-directed behavior is easily accessed and enacted when encountering the same context.

In the present thesis, I have described processes that underlie goal-directed habits, that is, habits as a form of automatic goal-directed behavior. However, when talking about automaticity, it is important to know to what extent the

behavior is *automatically* triggered and subsequently carried out. This knowledge will help to gain a better understanding of the potential ways to influence habits when we, for example, desires to change our habits. Automaticity in social behavior is characterized by four distinct features, also called the four horsemen of automaticity (Bargh, 1994): absence of intentionality, uncontrollability, unawareness, and efficiency. Most processes underlying behaviors are not automatic in an all-or-none fashion (Bargh, 1994; Moors & de Houwer, 2006) and might therefore also be controllable. The more the processes underlying the formation, maintenance and alteration of habits are typified by these features, the more automatic habits occur. These features thus provide specific understanding on how to influence them. Therefore, in the remaining part of this chapter, I will discuss how these features of automaticity are evident in the present research.

Furthermore, although automaticity in goal-directed habits seems evident in the domain of automatic goal pursuit (e.g., Aarts, 2007; Bargh, 1990a; Moskowitz et al., 2004), some researchers are not convinced of this conceptualization of habits (and even regard this idea as a contradiction). After discussing automaticity in goal-directed habits, I will discuss these different conceptualizations. Finally, I will focus on the findings as to the formation of counter-habitual intentions and specifically the implications of these findings for the alteration of habits, i.e. intentions to perform non-habitual behavior to attain the same goal.

Automaticity in goal-directed habits

In the last two decades, researchers have focused on different aspects of automaticity and especially how these aspects may also apply to the operation of goal-directed behaviors (e.g., Aarts & Dijksterhuis, 2000a, 2000b; Bargh, 1990a; Moskowitz, Gollwitzer, Wasel, & Schaal, 1999; Sheeran et al., 2005; Verplanken & Aarts, 1999). Bargh was one of the first to claim in his automotive model (1990a) that environmental cues can automatically facilitate access to goal-directed behaviors leaving the individual performing the behavior to be

unaware of the processes underlying the instigation of the behavior. He and others have argued that many of the mental processes underlying our social life are automatically triggered and are therefore important determinants of behavior (e.g., Bargh, 1996; Dijksterhuis, Chartrand, & Aarts, 2007; Hasher & Zacks, 1979; Hassin, 2005). Recent studies in the domain of automatic goal pursuit have provided further support for this idea (e.g., Aarts & Dijksterhuis, 2000a, 2003; Bargh, Gollwitzer, Lee-Chai, Barndollar, & Trotschel, 2001; Custers & Aarts, 2005; Moskowitz, 2002; Shah & Kruglanski, 2002).

As argued before, automaticity suggests that the mental processes underlying the goal-directed behavior are characterized by four distinct features, also called the four horsemen of automaticity (Bargh, 1994): unintentionality, uncontrollability, lack of awareness and efficiency (see also Moors & de Houwer, 2006). For the present case, this implies that habitual processes are unintentional because the behavior is triggered by the circumstances without an explicit desire or plan to perform them. Habitual processes are supposed to be uncontrollable as it is difficult, if not impossible, to slow down or stop the mental processes underlying the performance of the behavior. Lack of awareness suggests that people are unaware of the processes underlying the behavior. Finally, efficiency indicates that the habits are executed easily, i.e. with little mental effort thereby providing the opportunity to perform the behavior in parallel with other activities.

Researchers commonly agree that the (automatic) processes underlying habits are very efficient as these processes are rather effortless and require minimal attentional resources (e.g., Norman & Shallice, 1986; Verplanken, 2006; Wood et al., 2005). That is, it is generally acknowledged that "practice makes perfect" indicating that accessing and instigating the behavior requires less mental capacity or resources because habits are formed (i.e., repeatedly executing the behavior in the same stable environment; e.g., Ach, 1910; Jonides, 2004; Schneider & Chein, 2003; Wegner & Bargh, 1998) leaving those resources available for parallel activities. More interesting are the three other features – that is, unintentionality, uncontrollability and unawareness – and the

evidence for these features in the present research. I will do this by discussing the automaticity features for each chapter separately. The feature efficiency will thus not be part of this analysis.

One of the first findings that provide evidence for the automatic nature of goal-directed habits in Chapter 2 is that alternative means that are also available for goal enactment are inhibited *without explicit intent* to do so. Through the inhibitory processes, goal attainment can be instigated rather easily as it is not hindered by other (related) information in memory (Kuhl & Beckmann, 1985; Shah et al., 2002). The alternative means are assumed to be inhibited through a lateral inhibitory connection between both means in memory (e.g., M.C. Anderson, 2003). This inhibitory connection originates in memory after a first selection between the means is made and occurs to ease the memory search and retrieval for subsequent pursuit of the goal; Both means are activated through their (facilitative) association with the goal and the means that is more strongly activated by the goal will cause the other means to be inhibited before it reaches consciousness. Hence, this type of inhibition (that I refer to as implicit inhibition) should be distinguished from an other form of inhibition, also referred to as strategic inhibition or suppression (Wegner, 1994), that is strategically used to avoid consciously thinking about the suppressed information. Unfortunately, the issue whether this inhibitory process requires conscious awareness or not has rarely been defined in the literature, and when it is mentioned, the concept of inhibition has been used rather careless. That is, researchers have used the term inhibition to refer to explicit (i.e., suppression) as well as implicit inhibitory processes (cf. Dijksterhuis & Van Knippenberg, 1998, for an elaborate discussion on this issue).

An important difference between these two types of inhibition has to do with the consequences of the process. Whereas implicit inhibition results in the "forgetting" of information, suppression has an opposite effect: it causes information to become enhanced (or hyper) accessible (cf. Wegner, 1994; Wegner & Erber, 1992). The suppression of unwanted information often leads to failure as the suppressed information "rebounds" into consciousness (the

famous white bear effect: intentionally suppressing any thoughts about white bears causes one to think actually even more about white bears, Wegner, 1994; Wegner & Erber, 1992). The idea underlying this effect is that people have to monitor their accomplishment in suppressing the irrelevant information and exactly this monitoring causes the information to become accessible, even hyperaccessible, again. Suppression can therefore *hinder* other processes because one is mentally occupied with that information. On the other hand, as argued before, implicit inhibition occurs due to the lateral connections that reduces access to information that is activated but irrelevant and therefore can interfere, before it gains access to consciousness. So implicit inhibition *facilitates* the use of other processes in memory by preventing potential interference (e.g., Levy & Anderson, 2002; Macrae et al., 1995).

It seems logical that inhibition occurs implicitly; the aim of reducing access to the alternatives is that the interference between the different available means is resolved before these means reach conscious thought. When people conversely try to consciously suppress alternative means (after they already became conscious), they are not likely to succeed in their mission because these means will become even more accessible and will cause memory retrieval to be more difficult. This idea is supported by the finding that alternative means became more accessible (they were facilitated) instead of less accessible when they were asked to strategically suppress the alternative means to retrieve the target means more easily from memory. Hence, as research in Chapter 2 has shown, only through implicit inhibitory control people can engage in habit formation in a context with multiple means for goal attainment.

What does the present research tell us about the controllability of goal-directed habits? Controllability refers to fact that a process can be stopped once it is started. In other words, if goal-directed habits are controllable, it should be possible to regulate habitual behavior after it is activated in memory. It is expected that the habitual means will interfere with having intentions to use non-habitual means available in memory because they are facilitated when faced with the goal. In this respect, Chapter 3 shows that habitual means were

inhibited after intentions were formed to use the non-habitual means for goal pursuit. These findings imply that habits are less automatic when inhibitory control can be exerted to prevent their enactment. This idea fits with previous research that provides evidence that automatic processes are controllable with the help of intentional processes (e.g., Moskowitz et al., 1999; Sassenberg & Moskowitz, 2005; Sheeran & Abraham, 2003). The notion that goal-directed habits may be controllable, i.e. the intention to perform non-habitual behavior inhibits access to habitual means, may appear odd given the evidence in daily life about changing habits, e.g., most new-year resolutions to change one's habits do not result in actual behavior. It should be noted here, however, that control refers to the activation level of the mental representation of habitual means and not the actual control of performing the means as they occur in complex daily goals in life. I will return to this issue later.

The most prominent feature of automaticity found in the present research is the absence of intentionality. This feature was emphasized by the findings in Chapter 4 that strong habitual behaviors were carried out despite the absence of intentions, or in other words: upon the emergence of (strong) habits, behavior was no longer controlled by intentional processes. Further evidence for this unintentionality stems from different studies conducted by other researchers. It has been found in research on attitude-behavior models that the repeated performance of behaviors in a context supportive of habit formation predicts behavior above intentions (e.g., Bentler & Speckart, 1979; Ouellette & Wood, 1998; Verplanken et al., 1998). Habit strength thus attenuates the influence of intentional processes on subsequent behavior (e.g., Ronis et al., 1989; Triandis, 1980; Wood et al., 2005). Because habitual goal-directed behaviors are not set in motion by intentions, they should be brought about by something else. Research on nonconscious goal pursuit provided support that habitual behaviors are directly elicited by environmental cues (e.g., Aarts & Dijksterhuis, 2003; Aarts et al., 1998; Bargh & Gollwitzer, 1994; Chartrand & Bargh, 1996; Macrae & Johnston, 1998; Norman & Shallice, 1986). Through the

repeated performance of the same behavior in a stable context, the behavior is directly triggered when confronted with this context.

To sum up, the processes that underlie goal-directed habits are characterized by (at least) three of the four horsemen of automaticity: Habitual behavior can occur without intentions to conduct the behavior, without being aware of the process of inhibition that promotes habit formation, is likely to occur in an efficient manner, i.e., simultaneously with other activities, but it is controllable because habitual means are inhibited when intentions are formed to use non-habitual means for goal attainment. Thus goal-directed habits seem to be automatic in the sense that they are determined by intentions and occur without awareness of the processes involved in forming and performing the habits. As evident as this may be for researchers in the domain of automatic goal pursuit (e.g., Aarts, 2007; Bargh, 1990; Moskowitz, 2004), others have questioned this idea (e.g., Botvinick & Plaut, 2006; Neal et al., 2006). This difference in the conceptualization of habits is mainly concerned with distinct views on the concepts of intentionality and goal-directedness, the issue I will turn to next.

Issue of goal-directed habits

Researchers have been intrigued by habits for a long period of time, but the notion of habits as goal-directed behaviors is relatively modern (e.g., Aarts & Dijksterhuis, 2000a; Moskowitz et al., 2004; Wegner & Bargh, 1998). There is general agreement for the idea that behavior is directly triggered by contextual cues when encountering the appropriate situation. Despite this concordance, there is currently a debate in the literature on the notion of goal-directed habits, i.e. whether the goal is still necessary for the direct cuing of the behavior by the context (e.g., Aarts & Dijksterhuis, 2000a, 2000b; Balleine & Dickinson, 1998; Bargh, 1990b; Bargh & Williams, 2006; Botvinick & Plaut, 2006; Cooper & Shallice, 2006; Neal et al., 2006).

On the one hand, it is argued that habits are goal-independent and situational cues simply trigger access to the mental representation of the

behavior. Although the behavior was initially goal-directed and intentional, it is no longer performed for goal attainment when it is sufficiently repeated under the same circumstances and automatic processes take over (e.g., Balleine & Dickinson, 1998; Botvinick & Plaut, 2006). According to this view, intentionality and goal-directedness are equivalent. On the other hand, it is argued that behaviors that were initially goal-directed and regulated by intentional processes will result in the formation of goal-directed habits (e.g., Aarts & Dijksterhuis, 2000a; Bargh, 1990a). The habitual behavior is automatically elicited by the context but is still executed for the attainment of a specific goal. Importantly, according to this view goal-directedness is not the same as intentional (see also Bargh, 1990b).

So which of these conceptualizations of habits is accurate? Neal and colleagues (2006) also discussed this issue and concluded that "goal-driven responses tend to be dynamic and flexible… habits emerge in a rigid pattern… Thus, although implicit goals provide potentially powerful guides to action they do not plausibly explain the context cuing of habits" (p. 199). Although they acknowledge the existence of implicit goals (that people hold and pursue of which they are not consciously aware), it is not clear how they assume these goals are triggered and attained. Research on nonconscious goal pursuit has shown that goals can be activated and pursued implicitly when faced with the appropriate context (Aarts & Dijksterhuis, 2003; Bargh & Gollwitzer, 1994; Bargh et al., 2001; Holland, Hendriks, & Aarts, 2005). To pursue the goal, though, a specific means has to be selected and when the goal has already been pursued repeatedly with the same means, it is most likely that this means will be used again without considering alternatives and the goal is thus realized in a rather rigid manner.

The line of reasoning addressed above does not necessarily imply that all habits are goal-directed. For example, one may enter the room of one's colleague to ask a short question but before doing so one walks to the window to look outside. Although this latter behavior is not related to the current goal and serves no specific goal in itself (the behavior is not functional), performing

the behavior occurs automatically because it has been done many times before. I would therefore like to argue that there are two qualitatively different types of habit, i.e. goal-directed ones and simple stimulus-response associations. So how are we able to distinguish between these types of habits? One way to investigate this is to confront people with the context in which the habit is always executed but hinder the performance of the habitual behavior, e.g. simulate one's morning routines but ensure that one is unable to watch the morning news on television as one always does. Provided that people are motivated to attain their goal when it concerns a goal-directed habit (also known as goal commitment, e.g. Kruglanski et al., 2002; Moskowitz et al., 2004), they will search for or use an alternative manner to accomplish their goal (e.g., listen to the radio). However, this search for alternatives is less likely to occur when the habit is a rather simple response to an environmental cue.

Given the discussion on the conceptualization of habits, it is important to set up proper research that can distinguish between goal-directed habits and more stimulus-response driven habits. The example mentioned above can serve as a starting point.

Counter-habitual intentions and habit change

Assuming that habits are goal-oriented, intentions to perform habitual behavior will not induce actual goal-directed behavior because the whole process from entering the appropriate context until instigation of the actual behavior occurs without the involvement of conscious intent and even awareness. However, because the habitual behavior is often in line with their intentions (Wood et al., 2005) it might cause people to think they are acting according to their intentions (cf. Aarts, Custers, & Wegner, 2005; Wegner & Wheatley, 1999). Not only do people have intentions corresponding to their habits, they also form intentions to act differently – that is, to engage in non-habitual behavior to realize the same goal, e.g. one needs to exercise more and therefore intents to take the bicycle to work because one always goes by bus. The question, then, is how well people can act on these counter-habitual

intentions and can control their habits. As discussed before, habits are less automatic to the extent that they are controllable. The studies that were reported in Chapter 3 demonstrated that habitual means were inhibited and will therefore enhance the likelihood that the intended non-habitual behavior is carried out.

Inhibitory processes are thus functional to prevent habitual intrusion. However, this endeavor sounds easier than it might be. Inhibitory control may also call for mental effort and may draw resources away from other tasks or goals that are being pursued. Research on executive control and nonconscious goal pursuit have argued that inhibitory processes may use mental resources and may therefore have costs (Aarts, 2007; Hassin et al., 2006). Hence, shielding intentions from distraction may fail when these resources are not available (see also the discussion of Chapter 3) such as when these resources are used to engage in other goal-directed behaviors or tasks: when the habitual means cannot be inhibited, these means will be automatically triggered and hinder the counter-habitual intentions in memory. Chances are that execution of the intentions will be hampered. In case resources are available, intentions to use non-habitual means for goal attainment may still be difficult to implement, because habits are directly triggered by cues from the context in which habits have developed and still emerge. It is likely that the habitual behavior will become accessible and even performed when encountering the appropriate context, especially when inhibitory control is no longer available. Hence, the habit will most likely kick in when resources are used for a parallel activity and when they are performed in a stable context.

An important conclusion that can be drawn from this thesis is that both the stability of the context in which the habit is performed and inhibitory control are significant factors to consider. I will now discuss how these factors can be taken into account when we have the desire to change our habits by pursuing our goals in a different way.

First, interventions to change goal-directed habits may focus on changing the context in which the goal will be realized and therefore seem to provide an

easy opportunity to alter habits (Verplanken & Wood, 2006; Wood et al., 2005). Hence, pursuing the goal in a different context will disrupt the possibility to behave in the habitual manner, e.g., when one has moved to another neighborhood one can no longer rely on one's habits thereby providing the opportunity to form new habits (and in case goal attainment can be realized with the help of more than one unique means, inhibition is thus required for new habits to originate). As discussed before, there are three factors of the context that have to remain stable over time to support habit formation: location, time and situation. Only one of these factors has to change to modify the context. To guarantee, however, the hindrance of performing the habit, it would be wise to alter all three factors, e.g., to change one's lunch habits, one has to go to a different lunchroom, change one's lunch time and be accompanied by different colleagues.

However, it should be noted that changing the context requires a modification of the physical or social environment. Provided that this adventure may be rather difficult (e.g., not everyone is able to move to another physical or social environment), there may also be another strategy to alter habits. Intentions to perform non-habitual behavior are often aimed at the same context of the habitual behavior and they thus require inhibitory control. These intentions are therefore fragile as other goals or tasks that require executive control might hamper these intentional processes. Especially, because people differ in the extent to which working memory capacity allows them to control their habitual responses to interfere with their intention to use alternatives (e.g., Diefendorff et al., 1998; Mecklinger, Weber, Gunter, & Engle, 2003).

A different way to enlarge the likelihood that the intention will be executed, is by automatizing the enactment of the intention. This can be achieved through the formation of implementation intentions (e.g., Aarts & Dijksterhuis, 2000a; Gollwitzer & Sheeran, 2006; Wieber & Sassenberg, 2006). Although general intentions to perform different behavior might not result in habit change, concrete plans or implementation intentions might benefit intentions to perform non-habitual behavior as these intentions specify where, when and

how (information about the location, time and situation of the context) the behavior will be executed (see also Gollwitzer, Bayer, & McCulloch, 2005; Sheeran, Milne, Webb, & Gollwitzer, in press). Hence, the three distinct factors that characterize the context are associated with the non-habitual behavior in memory. Therefore it is more likely that encountering the appropriate context will result in the activation and subsequent instigation of the non-habitual behavior.

The context will not only trigger access to the non-habitual means, but also to the habitual means. Inhibitory processes are thus needed in addition to reduce access to the habitual means. To break habits and engage in alternative goal-directed behavior, one should not only form concrete plans to do so and rely on the inhibition of the habitual means but it would also be helpful to impede the habit from becoming accessible. Non-habitual intentions are more likely to result in actual behavior when the association strength between the context – goal – habitual means diminishes and the behavior is no longer automatically triggered by the environmental cues (e.g., Fishbach, Dhar, & Zhang, 2006; Fitzsimons & Bargh, 2004; Moskowitz et al., 2004; Zhang, Fishbach, & Kruglanski, 2007). Traditional strategies to change (habitual) behavior make often use of conscious strategies (e.g., protection motivation theory, Rogers, 1983; health belief model, Rosenstock, 1974; self-efficacy model, Bandura, 1977), for example, by informing people about the risks or disadvantages of their behavior.

Although these strategies may result in a change of intention, it does not necessarily lead to a change in behavior (Webb & Sheeran, 2006; see also this thesis, intentions are not predictive of behavior when strong habits have established). Moreover, these strategies aimed at intentional processes may even cause reactance (when people feel that their freedom to choose a behavior is threatened) which may motivate people not to perform the alternative behavior and even motivate to engage in their habitual behavior (Brehm, 1966). Recently, a different strategy has been explored in which negative affect is used in an implicit way: associating the context – goal –

habitual means with negative affect (Aarts, Custers, & Holland, 2007; Fishbach, Shah, & Kruglanski, 2004). As a result, motivation to engage in the behavior and consequently, operation of the behavior will cease.

In a preliminary study, we investigated the consequences of linking the habitual goal-means association to negative affect (Danner, Adriaanse, & Aarts, 2007c; see also Aarts et al., 2007). By means of an evaluative conditioning paradigm, habitual goal-directed behavior was either associated with negative information or with neutral information. The results of this study indicate that the habitual behavior was less accessible after linking it with negative affect than after linking it with neutral information. These findings may suggest that the motivation to use the habitual means for goal attainment declines and one will utilize a different means to attain the goal. Aarts (2007) argued that this motivation reduction mechanism might be especially useful when one is unaware of the processes activating and operating the goal, as is the case with habits: people can change their habitual pattern without having to switch to more intentional processes. By associating the habitual goal-directed behavior with negative affect, it may deteriorate its functioning: the habitual behavior is less likely to interfere with the intention to perform non-habitual behavior because the behavior will not be automatically (or to lesser extend) triggered. It may even lead to habit alteration, especially when the enactment of the counter-habitual intention is automatized through the formation of implementation intentions.

To put the previous discussed issues about habit change in a personal perspective: when I want to ensure that I will drink wine when I visit my friends in the pub next Friday night, I should go to a different pub (i.e., change the context), make a concrete plan on how to accomplish having wine in this pub (i.e., form implementation intention) and link the pub-socialize-beer association with negative affect. In case it is not possible to either change the context (e.g., there is only one pub in the village) or decrease the habitual association (e.g., the link with positive affect is too strong), it would be wise to

focus on one task at the same time to prevent load on the inhibitory mechanism which will provide the opportunity for habitual intrusion.

Conclusion

In this thesis I have aimed to investigate different aspects of goal-directed habits. I have used research from different fields (e.g., automatic goal pursuit, memory retrieval and intention-behavior models) to study the cognitive processes underlying habits, especially the role of inhibitory processes, and to study how habits can guide behavior. There is a long tradition of research on habits because they were acknowledged long ago to be an important part of daily life. It is not the importance of the habit itself that is currently subject to empirical debate but its conceptualization and subsequent operationalization. However, clarity of these matters is essential to gain understanding how habits are formed and maintained and how our daily behaviors are influenced by our habits.

In the current research I have argued and gathered further evidence for the idea that habits can be regarded as a specific form of automatic goal pursuit and as such can guide goal-directed behavior without conscious intent. I have shown how it is possible to perform goal-directed behavior in a habitual fashion whereas the means of attainment initially had to be considered. Not only are these inhibitory processes important to instigate habit formation, they are also necessary to resist these same habits when there is a desire to attain one's goal in a non-habitual way. Moreover, I have demonstrated that the context in which the habit emerged is an essential factor to consider. By showing the influence of inhibitory processes and the role of context stability, I have provided additional understanding of the difficulty and success of habit change. One can have the best intentions but the road to an actual change of behavior is filled with obstacles. Chances are that one will act by force of habit! These insights can provide a different starting point for the alteration of (undesired) habits.

References

Aarts, H. (2007). Health and goal-directed behavior: The nonconscious regulation and motivation of goals and their pursuit. *Health Psychology Review, 1*, 53-82.

Aarts, H., Custers, R., & Holland, R. W. (2007). The nonconscious cessation of goal pursuit: When goals and negative affect are coactivated. *Journal of Personality and Social Psychology, 92*, 165-178.

Aarts, H., Custers, R., & Wegner, D. M. (2005). On the inference of personal authorship: Enhancing experienced agency by priming effect information. *Consciousness and Cognition, 14*, 439-458.

Aarts, H., & Dijksterhuis, A. (2000a). Habits as knowledge structures: Automaticity in goal-directed behavior. *Journal of Personality and Social Psychology, 78*, 53-63.

Aarts, H., & Dijksterhuis, A. (2000b). The automatic activation of goal-directed behavior: The case of travel habit. *Journal of Environmental Psychology, 20*, 75-82.

Aarts, H., & Dijksterhuis, A. (2003). The silence of the library: Environment, situational norm, and social behavior. *Journal of Personality and Social Psychology, 84*, 18-28.

Aarts, H., Paulussen, T., & Schaalma, H. (1997a). Physical exercise habit: On the conceptualization and formation of habitual health behaviours. *Health Education Research: Theory and Practice, 12*, 363-374.

Aarts, H., Verplanken, B., & Van Knippenberg, A. (1997b). Habit and information use in travel mode choices. *Acta Psychologica, 96*, 1-14.

Aarts, H., Verplanken, B., & Van Knippenberg, A. (1998). Predicting behavior from actions in the past: Repeated decision making or a matter of habit? *Journal of Applied Social Psychology, 28*, 1355-1374.

Ach, N. (1910). *Uber den willensakt und das temperament*. Leipzig: Quelle & Meyer.

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

Ajzen, I. (2002). Residual effects of past on later behavior: Habituation and reasoned action perspectives. *Personality and Social Psychology Review, 6*, 107-122.

Ajzen, I., & Fishbein, M. (2000). Attitudes and the attitude-behavior relation: Reasoned and automatic processes. In W. Stroebe & M. Hewstone (Eds.), *European review of social psychology* (Vol. 11, pp. 1-33).

Altmann, E. M., & Trafton, J. G. (2002). Memory for goals: An activation-based model. *Cognitive Science, 26*, 39-83.

Anderson, J. R. (1983). *The architecture of cognition*. Cambridge, MA: Harvard University Press.

Anderson, J. R. (1993). Problem solving and learning. *American Psychologist, 48*, 35-44.

Anderson, M. C. (2003). Rethinking interference theory: Executive control and the mechanisms of forgetting. *Journal of Memory and Language, 49*, 415-445.

Anderson, M. C., Björk, R. A., & Björk, E. L. (1994). Remembering can cause forgetting: Retrieval dynamics in long-term memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 20*, 1063-1087.

Anderson, M. C., & Green, C. (2001). Suppressing unwanted memories by executive control. *Nature, 410*, 131-134.

Anderson, M. C., & Spellman, B. A. (1995). On the status of inhibitory mechanisms in cognition: Memory retrieval as a model case. *Psychological Review, 102*, 68-100.

Austin, J. T., & Vancouver, J. B. (1996). Goal constructs in psychology: Structure, process, and content. *Psychological Bulletin, 120*, 338-375.

Balleine, B. W., & Dickinson, A. (1998). Goal-directed instrumental action: Contingency and incentive learning and their cortical substrates. *Neuropharmacology, 37*, 407-419.

Bamberg, S., & Schmidt, P. (2003). Incentives, morality, or habit? Predicting students' car use for university routes with the models of Ajzen, Schwartz, and Triandis. *Environment and Behavior, 35*, 264-285.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review, 84*, 191-215.

Bargh, J. A. (1990a). Auto-motives: Preconscious determinants of social interaction. In E. T. Higgins & R. M. Sorrentino (Eds.), *Handbook of motivation and cognition* (Vol. 2, pp. 93-130). New York: Guilford Press.

Bargh, J. A. (1990b). Goal not-equal-to intent: Goal-directed thought and behavior are often unintentional. *Psychological Inquiry, 1*, 248-251.

Bargh, J. A. (1994). The four horsemen of automaticity: Awareness, intention, efficiency, and control in social cognition. In R. S. Wyer, Jr. (Ed.), *Handbook of social cognition* (Vol. 1, pp. 1-40). Hillsdale, NJ, England: Lawrence Erlbaum Associates, Inc.

Bargh, J. A. (1996). Automaticity in social psychology. In E. T. Higgins & A. W. Kruglanski (Eds.), *Handbook of basic principles* (pp. 169-183). New York: Guilford Press.

Bargh, J. A., & Chartrand, T. L. (1999). The unbearable automaticity of being. *American Psychologist, 54*, 462-479.

Bargh, J. A., & Gollwitzer, P. M. (1994). Environmental control of goal-directed action: Automatic and strategic contingencies between situations and behavior. In W. D. Spaulding (Ed.), *Integrative views of motivation, cognition, and emotion. Nebraska symposium on motivation* (Vol. 41, pp. 71-124). Lincoln, NE: University of Nebraska Press.

Bargh, J. A., Gollwitzer, P. M., Lee-Chai, A., Barndollar, K., & Trotschel, R. (2001). The automated will: Nonconscious activation and pursuit of behavioral goals. *Journal of Personality and Social Psychology, 81*, 1014-1027.

Bargh, J. A., & Williams, E. L. (2006). The automaticity of social life. *Current Directions in Psychological Science, 15*, 1-4.

Barnett, S. M., & Ceci, S. J. (2002). When and where do we apply what we learn? A taxonomy for far transfer. *Psychological Bulletin, 128*, 612-637.

Bäuml, K. H. (1998). Strong items get suppressed, weak items do not: The role of item strength in output interference. *Psychonomic Bulletin and Review, 5*, 459-463.

Beckmann, J. (1998). Intrusive thoughts, rumination, and incomplete intentions. In M. Kofta & G. Weary (Eds.), *Personal control in action: Cognitive and motivational mechanisms. The plenum series in social/clinical psychology* (pp. 259-278). New York, NY: Plenum Press.

Bentler, P. M., & Speckart, G. (1979). Models of attitude-behavior relations. *Psychological Review, 86*, 452-464.

Betsch, T., Haberstroh, S., & Höhle, C. (2002). Explaining routinized decision making: A review of theories and models. *Theory and Psychology, 12*, 453-488.

Blackmore, S. (2003). *Consciousness: An introduction*. New York: Oxford University Press.

Botvinick, M. M., & Plaut, D. C. (2006). Such stuff as habits are made on: A reply to Cooper and Shallice (2006). *Psychological Review, 113*, 917-927.

Brehm, J. W. (1966). *A theory of psychological reactance*. New York: Academic Press.

Chan, K. H., Morell, J. R., Jarrard, L. E., & Davidson, T. L. (2001). Reconsideration of the role of the hippocampus in learned inhibition. *Behavioural Brain Research, 119*, 111-130.

Chartrand, T. L., & Bargh, J. A. (1996). Automatic activation of impression formation and memorization goals: Nonconscious goal priming reproduces effects of explicit task instructions. *Journal of Personality and Social Psychology, 71*, 464-478.

Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. (2003). *Applied multiple regression/correlation analysis for the behavioral sciences (3rd ed.)*. Mahwah, NJ: Lawrence Erlbaum Associates Publishers.

Cooper, R., & Shallice, T. (2000). Contention scheduling and the control of routine activities. *Cognitive Neuropsychology, 17*, 297-338.

Cooper, R., & Shallice, T. (2006). Hierarchical schemas and goals in the control of sequential behavior. *Psychological Review, 113*, 887-916.

Custers, R., & Aarts, H. (2005). Positive affect as implicit motivator: On the nonconscious operation of behavioral goals. *Journal of Personality and Social Psychology, 89*, 129-142.

Dagenbach, D., & Carr, T. H. (1994). *Inhibitory processes in attention, memory, and language*. San Diego (CA): Academic Press, Inc.

Danner, U. N., Aarts, H., & De Vries, N. K. (2007a). Multiple options to goal attainment: Repeated retrieval of target means causes inhibited access to competitors. *Personality and Social Psychology Bulletin, 33*, 1367-1379

Danner, U. N., Aarts, H., & De Vries, N. K. (2007b). Strong habit intrusion in goal-directed behavior: Shielding intentions against habits. *Manuscript under review*.

Danner, U. N., Adriaanse, M., & Aarts, H. (2007c). *The positive consequences of negative affect: Cognitive alteration of habits by using evaluative conditioning.* Paper presented at the annual meeting of the Society of Personality and Social Psychology, Memphis, TS.

Danner, U. N., Aarts, H., & De Vries, N. K. (in press). Habit versus intention in the prediction of future behavior: The role of frequency, context stability and mental accessibility of past behavior. *British Journal of Social Psychology*.

Davidson, T. L., Kanoski, S. E., Walls, E. K., & Jarrard, L. E. (2005). Memory inhibition and energy regulation. *Physiology & Behavior, 86*, 731-746.

De Houwer, J. (2006). What are implicit measures and why are we using them? In R. W. Wiers & A. W. Stacy (Eds.), *The handbook of implicit cognition and addiction.* Thousand Oaks (CA): Sage Publishers.

Deci, E. L., & Ryan, R. M. (1985). *Intrinsic motivation and self-determination in human behavior*. New York: Plenum.

Dempster, F. N., & Brainerd, C. J. (1995). *Interference and inhibition in cognition*. San Diego (CA): Academic Press, Inc.

Dewey, J. (1929). *Experience and nature*. New York: W W Norton & Co.

Diefendorff, J. M., Lord, R. G., Hepburn, E. T., Quickle, J. S., Hall, R. J., & Sanders, R. E. (1998). Perceived self-regulation and individual differences in selective attention. *Journal of Experimental Psychology: Applied, 4*, 228-247.

Dijksterhuis, A., Chartrand, T. L., & Aarts, H. (2007). Effects of priming and perception on social behavior and goal pursuit. In J. A. Bargh (Ed.), *Social psychology and the unconscious: The automaticity of higher mental processes* (pp. 51-131). New York: Psychology Press.

Dijksterhuis, A., & Van Knippenberg, A. (1998). Inhibition, aberdeen, and other cloudy subjects. In R. S. Wyer, Jr. (Ed.), *Stereotype activation and inhibition* (Vol. 11, pp. 83-96). Mahwah, NJ: Lawrence Erlbaum Associates Publishers.

Dunlap, W. P., & Kemery, E. R. (1987). Failure to detect moderating effects: Is multicollinearity the problem? *Psychological bulletin, 102*, 418-420.

Eagly, A. H., & Chaiken, S. (1993). *The psychology of attitudes*. Orlando (Fl): Harcourt Brace Jovanovich College Publishers.

Einstein, G. O., & McDaniel, M. A. (2005). Prospective memory: Multiple retrieval processes. *Current Directions in Psychological Science, 14*, 286-290.

Engle, R. W. (2002). Working memory capacity as executive attention. *Current Directions in Psychological Science, 11*, 19-23.

Fazio, R. H., & Olson, M. A. (2003). Implicit measures in social cognition research: Their meaning and use. *Annual Review of Psychology, 54*, 297-327.

Ferguson, E., & Bibby, P. A. (2002). Predicting future blood donor returns: Past behavior, intentions, and observer effects. *Health Psychology, 21*, 513-518.

Fishbach, A., Dhar, R., & Zhang, Y. (2006). Subgoals as substitutes or complements: The role of goal accessibility. *Journal of Personality and Social Psychology, 91*, 232-242.

Fishbach, A., Shah, J. Y., & Kruglanski, A. W. (2004). Emotional transfer in goal systems. *Journal of Experimental Social Psychology, 40*, 723-738.

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention, and behavior: An introduction to theory and research*. Reading, MA: Addison-Wesley.

Fitzsimons, G. M., & Bargh, J. A. (2004). Automatic self-regulation. In K. D. Vohs & R. F. Baumeister (Eds.), *Handbook of self regulation: Research, theory, and applications* (pp. 151-170). New York: Guilford Press.

Freeman, J. E., & Ellis, J. A. (2003). The representation of delayed intentions: A prospective subject-performed task? *Journal of Experimental Psychology: Learning, Memory, and Cognition, 29*, 976-992.

Geen, R. G. (1995). *Human motivation: A social psychological approach*. Belmont (CA): Thomson Brooks/Cole Publishing Co.

Gollwitzer, P. M. (1990). Action phases and mind-sets. In R. M. Sorrentino & E. T. Higgins (Eds.), *Handbook of motivation and cognition: Foundations of social behavior* (Vol. 2, pp. 53-92). New York: Guilford Press.

Gollwitzer, P. M. (1999). Implementation intentions: Strong effects of simple plans. *American Psychologist, 54*, 493-503.

Gollwitzer, P. M., Bayer, U. C., & McCulloch, K. C. (2005). The control of the unwanted. In R. Hassin, J. Uleman & J. A. Bargh (Eds.), *The new unconscious* (pp. 485-515). Oxford: Oxford University Press.

Gollwitzer, P. M., & Moskowitz, G. B. (1996). Goal effects on action and cognition. In E. T. Higgins & A. W. Kruglanski (Eds.), *Social psychology: Handbook of basic principles* (pp. 361-399). New York: Guilford Press.

Gollwitzer, P. M., & Sheeran, P. (2006). Implementation intentions and goal achievement: A meta-analysis of effects and processes. *Advances in Experimental Social Psychology, 38*, 69-119.

Goschke, T., & Kuhl, J. (1993). Representation of intentions: Persisting activation in memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 19*, 1211-1226.

Hasher, L., & Zacks, R. T. (1979). Automatic and effortful processes in memory. *Journal of Experimental Psychology: General, 108*, 356-388.

Hassin, R. R. (2005). Nonconscious control and implicit working memory. In R. R. Hassin, J. S. Uleman & J. A. Bargh (Eds.), *The new unconscious* (pp. 196-222). New York: Oxford University Press.

Hassin, R. R., Aarts, H., Eitam, B., & Custers, R. (2006). Goals at work: Studies on the mechanics of automatic goal-pursuit. *Manuscript under review*.

Hay, J. F., & Jacoby, L. L. (1996). Separating habit and recollection: Memory slips, process dissociations, and probability matching. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 22*, 1323-1335.

Heckhausen, H., & Beckmann, J. (1990). Intentional action and action slips. *Psychological Review, 97*, 36-48.

Holland, R. W., Aarts, H., & Langendam, D. (2006). Breaking and creating habits on the working floor: A field-experiment on the power of implementation intentions. *Journal of Experimental Social Psychology, 42*, 776-783.

Holland, R. W., Hendriks, M., & Aarts, H. (2005). Smells like clean spirit. Nonconscious effects of scent on cognition and behavior. *Psychological Science, 16*, 689-693.

Hull, C. L. (1943). *Principles of behavior: An introduction to behavior theory*. Oxford: Appleton-Century.

James, W. (1890). *The principles of psychology*. London: Macmillan and Co., Ltd.

Jonides, J. (2004). How does practice makes perfect? *Nature Neuroscience, 7*, 10-11.

Kruglanski, A. W., Shah, J. Y., Fishbach, A., Friedman, R., Chun, W. Y., & Sleeth-Keppler, D. (2002). A theory of goal systems. In M. P. Zanna (Ed.),

Advances in experimental social psychology (Vol. 34, pp. 331-378). San Diego (CA): Elsevier Academic Press.

Kuhl, J. (1987). Action control: The maintenance of motivational states. In F. Halisch & J. Kuhl (Eds.), *Motivation, intention, and volition* (pp. 279–307). Berlin: Springer-Verlag.

Kuhl, J., & Beckmann, J. (1985). *Action control: From cognition to behavior*. Berlin: Springer.

Levy, B. J., & Anderson, M. C. (2002). Inhibitory processes and the control of memory retrieval. *Trends in Cognitive Sciences, 6*, 299-305.

Lewin, K. (1935). *A dynamic theory of personality*. New York: McGraw-Hill.

Logan, G. D., & Cowan, W. B. (1984). On the ability to inhibit thought and action: A theory of an act to control. *Psychological Review, 91*, 295-327.

Macrae, C. N., Bodenhausen, G. V., & Milne, A. B. (1995). The dissection of selection in person perception: Inhibitory processes in social stereotyping. *Journal of Personality and Social Psychology, 69*, 397-407.

Macrae, C. N., & Johnston, L. (1998). Help, I need somebody: Automatic action and inaction. *Social Cognition, 16*, 400-417.

Mäntylä, T. (1993). Priming effects in prospective memory. *Memory, 1*, 203-218.

Marsh, R. L., Hicks, J. L., & Bink, M. L. (1998). Activation of completed, uncompleted, and partially completed intentions. *Journal of Experimental Psychology-Learning Memory and Cognition, 24*, 350-361.

Matthies, E., Kuhn, S., & Klöckner, C. A. (2002). Travel mode choice of women: The result of limitation, ecological norm, or weak habit? *Environment and Behavior, 34*, 163-177.

Mayr, U. (2002). Inhibition in action rules. *Psychonomic Bulletin and Review, 9*, 93-99.

McCabe, D. P., Robertson, C. L., & Smith, A. D. (2005). Age differences in stroop interference in working memory. *Journal of Clinical and Experimental Neuropsychology, 27*, 633-644.

Mecklinger, A., Weber, K., Gunter, T. C., & Engle, R. W. (2003). Dissociable brain mechanisms for inhibitory control: Effects of interference content and working memory capacity. *Cognitive Brain Research, 18*, 26-38.

Mittal, B. (1988). Achieving higher seat belt usage: The role of habit in bridging the attitude-behavior gap. *Journal of Applied Social Psychology, 18*, 993-1016.

Montano, D. E., & Taplin, S. H. (1991). A test of an expanded theory of reasoned action to predict mammography participation. *Social Science and Medicine, 32*, 733-741.

Moors, A., & de Houwer, J. (2006). Automaticity: A theoretical and conceptual analysis. *Psychological bulletin, 132*, 297-326.

Moskowitz, G. B. (2002). Preconscious effects of temporary goals on attention. *Journal of Experimental Social Psychology, 38*, 397-404.

Moskowitz, G. B., Gollwitzer, P. M., Wasel, W., & Schaal, B. (1999). Preconscious control of stereotype activation through chronic egalitarian goals. *Journal of Personality and Social Psychology, 77*, 167-184.

Moskowitz, G. B., Li, P. Z., & Kirk, E. R. (2004). The implicit volition model: On the preconscious regulation of temporarily adopted goals. In M. Zanna (Ed.), *Advances in experimental social psychology* (Vol. 36, pp. 317-413). San Diego (CA): Academic Press.

Neal, D. T., Wood, W., & Quinn, J. M. (2006). Habits: A repeat performance. *Current Directions in Psychological Science, 15*, 198-202.

Nejad, L. M., Wertheim, E. H., & Greenwood, K. M. (2004). Predicting dieting behavior by using, modifying, and extending the theory of planned behavior. *Journal of applied social psychology, 34*, 2099-2131.

Nisbett, R. E., & Wilson, T. D. (1977). Telling more than we can know: Verbal reports on mental processes. *Psychological Review, 84*, 231-259.

Norman, D. A. (1981). Categorization of action slips. *Psychological Review, 88*, 1-15.

Norman, D. A., & Shallice, T. (1986). Attention to action: Willed and automatic control of behavior. In R. J. Davidson, G. E. Schwartz & D. Shapiro (Eds.),

Consciousness and self-regulation: Advances in research and theory (Vol. 4, pp. 1-18). New York: Plenum Press.

Ouellette, J. A., & Wood, W. (1998). Habit and intention in everyday life: The multiple processes by which past behavior predicts future behavior. *Psychological Bulletin, 124*, 54-74.

Perfect, T. J., Moulin, C. J. A., Conway, M. A., & Perry, E. (2002). Assessing the inhibitory account of retrieval-induced forgetting with implicit-memory tests. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 28*, 1111-1119.

Radvansky, G. A. (1999). Memory retrieval and suppression: The inhibition of situation models. *Journal of Experimental Psychology: General, 128*, 563-579.

Reason, J. (1979). Actions not as planned: The price of automatization. In G. Underwood & R. Stevens (Eds.), *Aspects of unconsciousness* (pp. 67-89). London: Academic Press.

Rogers, R. W. (1983). Cognitive and physiological processes in fear appeals and attitude change: A revised theory of protection motivation. In B. L. Cacioppo & L. L. Petty (Eds.), *Social psychophysiology: A sourcebook*. London: Guilford.

Ronis, D. L., Yates, J. F., & Kirscht, J. P. (1989). Attitudes, decisions, and habits as determinants of repeated behavior. In A. R. Pratkanis, S. J. Breckler & A. G. Greenwald (Eds.), *Attitude structure and function* (pp. 213-239). Hillsdale, NJ, England: Lawrence Erlbaum Associates, Inc.

Rosenstock, I. M. (1974). Historical origins of the health-belief model. *Health Education Monographs, 2*, 1-8.

Sassenberg, K., & Moskowitz, G. B. (2005). Don't stereotype, think different! Overcoming automatic stereotype activation by mindset priming. *Journal Of Experimental Social Psychology, 41*, 506-514.

Schneider, W., & Chein, J. M. (2003). Controlled & automatic processing: Behavior, theory, and biological mechanisms. *Cognitive Science, 27*, 525-559.

Shah, J. Y. (2003). Automatic for the people: How representations of significant others implicitly affect goal pursuit. *Journal of Personality and Social Psychology, 84*, 661-681.

Shah, J. Y. (2005). The automatic pursuit and management of goals. *Current Directions in Psychological Science, 14*, 10-13.

Shah, J. Y., Friedman, R., & Kruglanski, A. W. (2002). Forgetting all else: On the antecedents and consequences of goal shielding. *Journal of Personality and Social Psychology, 83*, 1261-1280.

Shah, J. Y., & Kruglanski, A. W. (2002). Priming against your will: How accessible alternatives affect goal pursuit. *Journal of Experimental Social Psychology, 38*, 368-383.

Sheeran, P., Aarts, H., Custers, R., Rivis, A., Webb, T. L., & Cooke, R. (2005). The goal-dependent automaticity of drinking habits. *British Journal Of Social Psychology, 44*, 47-63.

Sheeran, P., & Abraham, C. (2003). Mediator of moderators: Temporal stability of intention and the intention-behavior relation. *Personality and Social Psychology Bulletin, 29*, 205-215.

Sheeran, P., Milne, S., Webb, T. L., & Gollwitzer, P. M. (in press). Implementation intention and health behaviours. In M. Conner & P. Norman (Eds.), *Predicting health behaviors: Research and practice with social cognition models (2nd ed.)*. Buckingham, UK: Open University Press.

Shim, S., & Maggs, J. (2005). A cognitive and behavioral hierarchical decision-making model of college students' alcohol consumption. *Psychology and marketing, 22*, 649-668.

Shivde, G., & Anderson, M. C. (2001). The role of meaning selection: Insights from retrieval-induced forgetting. In D. S. Gorfein (Ed.), *On the consequences of meaning selection: Perspectives on resolving lexical ambiguity. Decade of behavior.* (pp. 175-190). Washington (DC): American Psychological Association.

Skinner, B. F. (1938). *The behavior of organisms: An experimental analysis*. New York: Appleton-Century-Crofts.

Skinner, B. F. (1953). *Science and human behavior*. New York: Macmillan.

Sutton, S. (1994). The past predicts the future: Interpreting behaviour-behaviour relationships in social psychological models of health behaviour. In D. R. Rutter & L. Quine (Eds.), *Social psychology and health: European perspectives* (pp. 71-88). Brookfield (VT): Avebury/Ashgate Publishing Co.

Tipper, S. P. (2001). Does negative priming reflect inhibitory mechanisms? A review and integration of conflicting views. *The Quarterly Journal of Experimental Psychology, 54*, 321-343.

Triandis, H. C. (1980). *Values, attitudes, and interpersonal behavior.* Paper presented at the Nebraska Symposium on Motivation: Beliefs, attitudes, and values, 1979, Lincoln.

Veling, H., & Van Knippenberg, A. (2004). Remembering can cause inhibition: Retrieval-induced inhibition as cue independent process. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 30*, 315-318.

Veling, H., & Van Knippenberg, A. (2006). Shielding intentions from distraction: Forming an intention induces inhibition of distracting stimuli. *Social Cognition, 24*, 409-425.

Verplanken, B. (2006). Beyond frequency: Habit as mental construct. *British Journal of Social Psychology, 45*, 639-656.

Verplanken, B., & Aarts, H. (1999). Habit, attitude, and planned behavior: Is habit an empty construct or an interesting case of goal-directed automaticity? In W. Stroebe & M. Hewstone (Eds.), *European review of social psychology* (Vol. 10, pp. 101-134). Chichester, England: Wiley.

Verplanken, B., Aarts, H., Van Knippenberg, A., & Moonen, A. (1998). Habit versus planned behavior: A field experiment. *British Journal of Social Psychology, 37*, 111-128.

Verplanken, B., Myrbakk, V., & Rudi, E. (2005). The measurement of habit. In T. Betsch & S. Haberstroh (Eds.), *The routines of decision making* (pp. 231-247). Mahwah (NJ): Lawrence Erlbaum Associates, Publishers.

Verplanken, B., & Orbell, S. (2003). Reflections on past behavior: A self-report index of habit strength. *Journal of Applied Social Psychology, 33*, 1313–1330.

Verplanken, B., & Wood, W. (2006). Interventions to break and create consumer habits. *Journal of Public Policy & Marketing, 25*, 90-103.

Watson, J. B. (1914). *Behavior: An introduction to comparative behavior*. New York: Henry Holt & Co.

Webb, T. L., & Sheeran, P. (2006). Does changing behavioral intentions engender behavior change? A meta-analysis of the experimental evidence. *Psychological Bulletin, 132*, 249-268.

Wegner, D. M. (1994). Ironic processes of mental control. *Psychological Review, 101*, 34-52.

Wegner, D. M., & Bargh, J. A. (1998). Control and automaticity in social life. In D. T. Gilbert, S. T. Fiske & G. Lindzey (Eds.), *The handbook of social psychology* (Vol. 1, pp. 446-496). New York: McGraw-Hill.

Wegner, D. M., & Erber, R. (1992). The hyperaccessibility of suppressed thoughts. *Journal of Personality and Social Psychology, 63*, 903-912.

Wegner, D. M., & Vallacher, R. R. (1986). Action identification. In R. M. Sorrentino & E. T. Higgins (Eds.), *Handbook of motivation and cognition: Foundations of social behavior* (pp. 550-582). New York: Guilford Press.

Wegner, D. M., & Wheatley, T. (1999). Apparent mental causation: Sources of the experience of will. *American Psychologist, 54*, 480-492.

Weiner, B. (1985). An attributional theory of achievement motivation and emotion. *Psychological Review, 92*, 548-573.

Wieber, F., & Sassenberg, K. (2006). I can't take my eyes off of it: Attention attraction effects of implementation intentions. *Social Cognition, 24*, 723-752.

Wittenbraker, J., Gibbs, B. L., & Kahle, L. R. (1983). Seat belt attitudes, habits, and behaviors: An adaptive amendment to the Fishbein model. *Journal of Applied Social Psychology, 13*, 406-421.

Wood, W., Tam, L., & Querrero Witt, M. (2005). Changing circumstances, disrupting habits. *Journal of Personality and Social Psychology, 88*, 918-933.

Zhang, Y., Fishbach, A., & Kruglanski, A. W. (2007). The dilution model: How additional goals undermine the perceived instrumentality of a shared path. *Journal of Personality and Social Psychology, 92*, 389-401.

Summary

Many of our daily behaviors serve to attain specific goals but nevertheless are performed in absence of conscious awareness. We are able to do so because we have performed these goal-directed behaviors frequently before. For example, on working days I always have a sandwich with cheese (behavior) for lunch (goal) without much conscious thought. When someone asks me why I always have this sandwich and not a different sandwich every now and then, I have to admit that I do so *by force of habit*.

Researchers in psychology have been interested in habits for over more than a century. William James already dedicated an entire chapter to habits in his Principles of Psychology (1890) and emphasized the importance of habits in human life. The concept of habit has also been a central topic in behaviorism (e.g., Hull, 1943; Skinner, 1938; Watson, 1914). Behaviorism regarded habits as simple stimulus-response associations, thereby reducing human behavior to rigid behavioral patterns that automatically follow environmental cues. However, together with the behaviorist tradition the interest in habits dwindled for several decades until researchers became interested again in the topic in the context of attitude-behavior models (e.g., Bentler & Speckart, 1979; Ronis, Yates & Kirscht, 1989; Triandis, 1980). For a long time, intentional processes were considered to control behavior but more emphasis was now placed on the impact of past behavior on future behavior.

More recently, the point of interest became not only to determine *when* habits will predict behavior above intentions but also *how* habits can guide later behavior by focusing on the mental processes underlying habits (e.g., Aarts & Dijksterhuis, 2000; Bargh, 1990; Sheeran et al., 2005). It was argued that habits can be regarded as a distinct form of automatic goal-directed behavior. They are established through the repeated selection and utilization of the same behavior (having a cheese sandwich) to achieve the same goal (lunch) in the same context (working days). Therefore, the context, goal and behavior

become mentally associated in memory. When one is subsequently confronted with this context, the goal becomes automatically accessible and causes the behavior to be automatically activated and instigated. Intentional control is no longer required.

The aim of this thesis is to examine how goal-directed habits are formed and established. Specifically, I will analyze the cognitive mechanism underlying habits and the role of habits in guiding goal-directed behavior.

In Chapter two, three studies examined the cognitive processes underlying the formation of goal-directed habits in a multiple means context. Habits are formed through the repeated retrieval and selection of a specific means for goal attainment. Repeated retrieval of target means upon goal activation was expected to result in inhibition of competing means for the same goal. In all studies, participants studied goal–means combinations and subsequently practiced the retrieval of certain means to attain the goals. Study 2.1 tested accessibility of the different means in a goal-means verification task and showed that competing means were not inhibited after a single retrieval, but only upon repeated retrieval (three- or nine-times). Studies 2.2 and 2.3 extended these findings in a means-recognition task and demonstrated that inhibition occurred in the absence of explicit intent or instructions to suppress the competitors.

In Chapter three, two studies examined whether the formation of intentions to pursue a goal in a non-habitual manner causes inhibited access to habitual means to attain that goal. Utilizing an idiosyncratic approach to assess personalized goal-means relations, Study 3.1 showed that the mental representation of habitual means is more readily accessed upon goal priming than non-habitual means, thus revealing the potential interference of the habitual means upon the formation of intentions to use non-habitual means. Furthermore, findings in Study 3.2 indicated that the formation of an intention to use non-habitual means inhibited the representations of the habitual means, while the intention to use habitual means did not cause inhibited access to non-habitual means.

In Chapter four, the role of habit and intention in the prediction of future behavior was examined by analyzing whether past behavior frequency moderates the intention-behavior relationship to the extent that the context in which the behavior 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 behavior frequency was considered: intentions guided future behavior when habits were weak (low frequency or unstable context), whereas 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 behavior is automatically activated by the context, mental accessibility of the behavior (i.e., the ease of accessing the goal-directed behavior in memory) moderates the intention-behavior relation in a similar way.

To summarize, the research in this thesis emphasizes the importance of two factors underlying habits that so far have almost not been considered: the influence of inhibitory processes and the role of context stability. So what are the implications of these findings? How is it possible to influence habits and what difficulties might be expected? These questions are discussed in the final Chapter.

The easiest way to influence habits is by changing the behavioral context. However, often we intend to alter our habits by achieving the same goal in the *same context* in a different manner (e.g., have a different sandwich for lunch on working days). This will be a difficult endeavor especially when habits are strong: the context is likely to facilitate access to the habitual goal-directed behavior, i.e. the behavior is no longer under intentional control. As a consequence one's non-habitual intentions are likely to be hampered, e.g. although I intend to have an egg sandwich for lunch, I finally find myself eating my usual cheese sandwich. Fortunately, the present research suggests that inhibitory control can prevent habitual intrusion from hindering the intention.

Nederlandse Samenvatting

Veel van ons dagelijks gedrag is gericht op het bereiken van specifieke doelen maar wordt uitgevoerd zonder dat we er ons bewust van zijn. We zijn hiertoe in staat omdat we deze doelgerichte gedragingen reeds vaak vertoond hebben. Bijvoorbeeld, op werkdagen neem ik als lunch altijd een broodje kaas zonder er echt bewust over na te denken. Wanneer iemand mij vraagt waarom ik altijd dit broodje neem en niet af en toe een ander broodje, dan moet ik toegeven dat ik dit doe *uit macht der gewoonte*.

Onderzoekers op het gebied van de psychologie zijn al meer dan een eeuw geïnteresseerd in gewoontes. William James wijdde een heel hoofdstuk aan gewoontes in zijn Principles of Psychology (1890) en benadrukte het belang van gewoontes in het menselijk leven. Het concept gewoonte was ook een centraal onderwerp in het behaviorisme (bv., Hull, 1943; Skinner, 1938; Watson, 1914). Behaviorisme beschouwde gewoontes als simpele stimulus-respons associaties, en reduceerde daarmee menselijk gedrag tot rigide gedragspatronen die automatisch volgen op cues uit de omgeving. Echter, tegelijkertijd met het behaviorisme leek ook de interesse in gewoontes te verdwijnen totdat onderzoekers in de context van attitude-gedrags modellen weer geïnteresseerd raakten (e.g., Bentler & Speckart, 1979; Ronis, Yates & Kirscht, 1989; Triandis, 1980). Gedurende een lange tijd werd verondersteld dat intentionele processen gedrag sturen, maar nu werd (weer) meer nadruk gelegd op de invloed van gedrag uit het verleden op gedrag in de toekomst.

Recentelijk is er niet alleen aandacht voor het bepalen *wanneer* gewoontes (beter dan intenties) gedrag voorspellen, maar ook *hoe* gewoontes in staat zijn toekomstig gedrag te sturen, door zich te richten op de mentale processen die ten grondslag liggen aan gewoontes (bv., Aarts & Dijksterhuis, 2000; Bargh, 1990; Sheeran et al., 2005). Vanuit dit perspectief wordt beargumenteerd dat gewoontes kunnen worden gezien als een aparte vorm van automatisch doelgericht gedrag. Zij ontstaan door herhaalde selectie en gebruik van

hetzelfde gedrag (een broodje kaas nemen) om hetzelfde doel te bereiken (lunch) in dezelfde context (werkdagen). Daardoor ontstaat er een mentale associatie in het geheugen tussen de context, het doel en het gedrag. Wanneer men vervolgens met deze context geconfronteerd wordt, dan wordt het doel automatisch toegankelijk dat er weer voor zorgt dat het gedrag automatisch geactiveerd en op gang gebracht wordt. Intentionele controle is niet langer nodig.

Het doel van dit proefschrift is om te onderzoeken hoe doelgerichte gewoontes worden gevormd en in stand worden gehouden. Meer specifiek wil ik meer inzicht krijgen in het cognitieve mechanisme dat ten grondslag ligt aan gewoontes en de rol van gewoontes in de sturing van doelgericht gedrag.

In hoofdstuk twee wordt met behulp van drie studies het cognitieve proces onderzocht dat ten grondslag ligt aan het vormen van doelgerichte gewoontes in een context met meerdere middelen voor hetzelfde doel. Gewoontes worden gevormd door het herhaaldelijk ophalen uit het geheugen en selecteren van een specifiek middel om het doel mee te bereiken. Er werd verwacht dat het herhaaldelijk ophalen van een specifiek middel na activatie van het doel zal resulteren in het inhiberen van een ander middel voor hetzelfde doel. In alle studies bestudeerden de participanten doel-middel combinaties en haalden zij vervolgens een specifiek middel om het doel mee te verwezenlijken op uit het geheugen. In Studie 2.1 werd de toegankelijkheid van de middelen getest in een doel-middel verificatie taak en werd er gevonden dat alternatieve middelen alleen na herhaaldelijk ophalen geïnhibeerd waren. Studies 2.2 en 2.3 breidden deze bevindingen uit in een middel-recognitie taak en toonden aan dat inhibitie alleen plaatsvindt in afwezigheid van expliciete intenties of instructies om het alternatieve middel weg te drukken.

In hoofdstuk drie werd met behulp van twee studies onderzocht of het vormen van intenties om het doel na te streven met een niet-habitueel middel leidt tot het inhiberen van het habituele middel voor dat doel. Er werden persoonlijke doel-middel relaties gebruikt die middels een idiosyncratische procedure achterhaald werden. Studie 3.1 toonde aan dat de mentale

representatie van de habituele middelen makkelijker toegankelijk was na priming met het doel dan de representatie van niet-habituele middelen. Hierdoor werd duidelijk dat habituele middelen kunnen interfereren met het vormen van een intentie om non-habituele middelen te gebruiken. Vervolgens lieten de resultaten in Studie 3.2 zien dat het vormen van een intentie om een non-habitueel middel te gebruiken leidde tot de inhibitie van de representatie van het habituele middel. Er werd tevens gevonden dat het vormen van de intentie om het habituele middel te gebruiken niet leidde tot inhibitie van het niet-habituele middel.

In hoofdstuk vier werd de rol van gewoontes en intenties in het voorspellen van toekomstig gedrag onderzocht. Dit werd gedaan door te testen of de frequentie waarmee gedrag in het verleden werd uitgevoerd, de intentie-gedrag relatie alleen modereert wanneer het gedrag in het verleden is uitgevoerd in een stabiele context. In twee correlationele studies werd gevonden dat gewoontes interacteerden met intenties wanneer de stabiliteit van de context in ogenschouw werd genomen: intenties stuurden toekomstig gedrag wanneer gewoontes zwak waren (lage frequentie of onstabiele context), terwijl dit niet het geval was wanneer gewoontes sterk waren (hoge frequentie en stabiele context). Een derde exploratieve studie onderzocht en bevestigde het idee dat als habitueel doelgericht gedrag automatisch geactiveerd wordt door de context, de mentale toegankelijkheid van het gedrag (m.a.w. het gemak waarmee men toegang krijgt tot het gedrag in het geheugen) de intentie-gedrag relatie op een vergelijkbare manier modereert.

Samenvattend, het onderzoek in dit proefschrift onderstreept het belang van twee factoren die ten grondslag liggen aan gewoontes en die tot dusver bijna niet in ogenschouw zijn genomen: the invloed van inhibitoire processen en de rol van de stabiliteit van de context. Wat zijn de implicaties van deze bevindingen? Hoe kunnen we gewoontes beïnvloeden en welke moeilijkheden kunnen we verwachten? Deze vragen komen in het laatste hoofdstuk aan bod.

De makkelijkste manier om gewoontes te beïnvloeden is door het veranderen van de context. Echter, vaak hebben we de intentie om onze

gewoontes te veranderen door hetzelfde doel in *dezelfde context* op een andere manier na te streven (bijvoorbeeld wanneer we op werkdagen een ander broodje als lunch willen nemen). Dit is een moeilijke onderneming, met name wanneer gewoontes sterk zijn: de context zal waarschijnlijk de toegankelijkheid van het habituele doelgerichte gedrag faciliteren; het gedrag wordt niet langer intentioneel gecontroleerd. Daardoor zullen de non-habituele intenties gehinderd worden, bijvoorbeeld: ook al wil ik een broodje ei als lunch, uiteindelijk ontdek ik dat mijn gebruikelijke broodje kaas op mijn bord heb liggen. Gelukkigerwijs suggereert het huidige onderzoek ook dat deze habituele intrusies voorkomen kunnen worden en dat de intenties beschermd worden met behulp van inhibitoire controle.

Dankwoord

Onderzoek doen naar gewoontes doet je realiseren dat veel van je eigen gedrag ook uit macht der gewoonte wordt uitgevoerd. Vaak kom ik 's ochtends met de fiets aan op Amsterdam Amstel en realiseer ik me dat ik net een heel stuk gefietst heb zonder mij op dat moment daar ook werkelijk bewust van te zijn. Hoe heb ik dan mijn route gekozen en hoe ben ik dan de straat overgestoken? Aan de andere kant heeft dit mij wel de mogelijkheid geboden om te bedenken dat het de eerste van de maand is en ik dus een nieuwe maandkaart moet kopen. Kennelijk zijn gewoontes niet alleen maar slecht, maar hebben zij dus ook voordelen.

Dit inzicht heb ik vooral gekregen dankzij de afgelopen jaren. En daarom wil ik nu een aantal mensen noemen die mij hierbij hebben geholpen.

Henk, met wie zou ik anders kunnen en willen beginnen. Ik had me geen betere leermeester kunnen voorstellen. Jouw passie om (onbewust doelgericht) gedrag te willen begrijpen door onderliggende processen te onderzoeken en de manier waarop je dit doet, is een groot voorbeeld voor me. Ook ben ik je dankbaar voor de manier waarop jij je met je aio's bezighoudt. Uiteraard zijn de afgelopen vier jaar met veel pieken en dalen verlopen, maar het eindresultaat is toch heel mooi. Ik durf nu wel te zeggen dat ik trots op ons ben!

Mijn dank gaat ook uit naar Nanne, mijn tweede promotor. Het project is niet gelopen zoals we allemaal gedacht hadden, maar ik vind het toch fijn dat we regelmatig konden overleggen en ik dankzij jou de mogelijkheid kreeg om af en toe ook mijn onderzoek op andere bijeenkomsten te presenteren. Marit, ik vind het fijn om de eerste drie jaar met jou te hebben samengewerkt en de begeleidingsperikelen met jou te hebben gedeeld. Ik hoop dat je nu heel gelukkig bent in je nieuwe werk.

Dan is er het oorspronkelijke doelgroepje: Ruud, Giel, Esther en Martijn dat uiteindelijk uitgroeide tot de Scan-meeting. Ik heb veel gehad aan de vele gesprekken over onderzoek, begeleider, het probleem van bier drinken en daarbij vis eten, en de gezelligheid in de kroeg. Esther, jou wil ik nog even apart noemen, want naast het feit dat je echt een vriendin van me bent geworden, heb ik mijn nieuwe baan mede aan jou te danken!

De overige mensen van mijn afdeling wil ik ook bedanken voor een gezellige tijd. Vooral Maureen, mijn roomie. Het was fijn om altijd bij iemand terecht te kunnen, zowel om te lachen als om te huilen als om de laatste roddels te horen. Beate, ik vond het ook erg leuk om nog heel even met jou een kamer te delen. In de vier jaar die ik er rond heb gelopen is de afdeling enorm gegroeid en is er een fantastische onderzoeksgroep ontstaan.

Onderzoek is met name leuk wanneer je dit ook met andere kunt bespreken die je weer een ander perspectief bieden. Ik heb uitgebreid de mogelijkheid gekregen om dit te doen op buitenlandse congressen (SPSP, Escon) en op binnenlandse bijeenkomsten (social cognition groep van het KLI, ASPO). En meer specifiek heb ik mijn onderzoek met mensen van de Nijmegen-groep besproken: Harm, Rob en Ad, jullie enthousiasme was altijd weer fijn.

Karin, hoeveel nieuwe culinaire buurten kunnen we nog ontdekken in Amsterdam? We spraken ooit af omdat we wel nieuwsgierig naar elkaar waren aangezien onze begeleiders zo goed bevriend zijn. Inmiddels zijn we zelf goed bevriend geraakt en ik hoop dat dat nog lang zo zal blijven.

Als laatste collega wil ik Wilco noemen. Als jij Henk niet verteld had dat ik zo'n enorme kroegtijger ben, dan was ik vast nooit aangenomen. Jij hebt tijdens mijn studie altijd voor mij en mijn medestudenten klaargestaan en ons allerlei extra mogelijkheden geboden. Daar heb ik dan ook altijd dankbaar gebruik van gemaakt. Ik ben blij dat ik me nu weer kan gaan verdiepen in het onderwerp Emoties.

Weliswaar ook een collega en een medestudent, maar nog veel meer een hele goede vriendin: Myrke, mijn mede-nimf. Dank voor je immer luisterende oor! En natuurlijk Roosje, pootje, mijn andere paranimf. Wat kan er veel gebeuren in 25 jaar vriendschap, en tegelijkertijd verandert er gelukkig weinig. Het maakt niet uit waar je bent, zolang er maar een telefoon in de buurt is…
En natuurlijk Celeste, Charlotte en alle andere vrienden die ik nu niet noem. Het is soms fijn om even in de andere werkelijkheid te stappen en met iets anders bezig te zijn. Mijn dank daarvoor!

Dan is er de familia. Broer, Smoerf, Broertje, Joyce en Bernd. Er is een hoop gebeurd de afgelopen jaren en ik ben blij dat we er dan altijd weer voor elkaar waren. Irrebeer, mijn grote zus, dat we nog maar een hoop mogen lachen en dat de familie alleen nog maar groter mag worden... Erica, of het nou een nieuwe baan is, familie perikelen of een wetenschappelijke vraag, het is altijd weer fijn om met je te kletsen of gewoon een filmpje te pakken.

Tenslotte, lieve pap en mam. Ik noem jullie toch in één adem. Dank voor de vrijheid en het vertrouwen dat jullie me altijd hebben gegeven in het maken van mijn keuzes. Paps, jij bent altijd een wetenschappelijk voorbeeld voor me geweest. Het is niet voor niets dat de gezondheidshoek mij nog steeds zo trekt en ik daar nu een "echte baan" in heb gevonden. Mams, het is fijn om te weten dat ik altijd op jou terug kan vallen, dat heeft mij met name het afgelopen jaar een hoop rust gebracht. Vanaf nu kan het alleen maar beter worden.

En dat allemaal voor mijn 30ste…

Curriculum Vitae

Unna Nora Danner is geboren op 19 november 1977 te Amsterdam. Zoals de meeste leden van haar familie doorliep zij het lagere onderwijs bij de Peetersschool en vervolgde zij het onderwijs op het St. Ignatius Gymnasium alwaar zij in 1996 haar diploma haalde. Aangezien zij haar zinnen op de studie Geneeskunde had gezet en nog niet werd toegelaten, begon zij haar volwassen leven met een jaartje werk-ervaring opdoen. Daarna begon zij de studie Psychologie aan de Vrije Universiteit met de intentie om uiteindelijk arts te worden. Maar zoals intenties wel vaker niet tot gedrag leiden, ontdekte zij de afstudeerrichting Sociale Psychologie en liet de uitkomst van de derde loting voor Geneeskunde beslissen welke studie het zou worden. De beslissing moge duidelijk zijn. Aangezien de wereld groter is dan alleen Amsterdam, heeft zij in het academische jaar 2000/2001 haar MSc in Social and Applied Psychology aan de University of Kent at Canterbury gehaald. Alsof dit nog niet voldoende was studeerde zij het jaar daarop ook af aan de Vrije Universiteit. In februari 2003 begon zij aan haar AiO-schap onder leiding van Prof.dr. Aarts aan de Universiteit Utrecht. Unna werkt momenteel als Post-doc onderzoekster en is hierbij verbonden aan zowel Rintveld, Centrum Eetstoornissen (Altrecht) als aan de afdeling Klinische & Gezondheidspsychologie van de Universiteit Utrecht.

The "Kurt Lewin Institute Dissertation Series" started in 1997. Since 2005 the following dissertations have been published:

2005-1: Elsbeth Steenland: *Stereotype Change: Effects of disconfirming information*
2005-2: Annet de Lange: *What about causality? Examining longitudinal relations between work characteristics and mental health*
2005-3: Reint Jan Renes: *Sustained volunteerism: Justification, motivation and management*
2005-4: Aloyse Augusta Dinsbach: *Socialization in the workplace: A focus on migrant groups*
2005-5: Susanne Peters: *The social psychology of being better off than others*
2005-6: Winny Bakker: *Emigration and well-being: The role of personality and cultural identity in acculturation*
2005-7: Ruud Zaalberg: *The expression of emotion in social situations. The mediating roles of display rules and social motives*
2005-8: Catharine Evers: *Sex differences in anger expressions. The shaping role of social appraisals*
2005-9: Ed Sleebos: *The Consequences of Perceived Intra-group Respect: The Effects of Differential Intra-group Respect on Behavior and Cognition*
2005-10: Jeroen Stouten: *Virtue Summons the Fury: Coordination Rules and Fairness in Social Dilemmas*
2005-11: Irene de Pater: *Doing Things Right or Doing the Right Thing: A New Perspective on the Gender Gap in Career Success*
2005-12: Rob Nelissen: *Guided by Reason, Struck by Emotion: Integrating Motivational & Expectancy - Value Accounts of Behavior*
2005-13: Emely de Vet: *Testing the Transtheoretical Model: Validity and Applicability for Fruit Intake*
2005-14: Floor Rink: *Diversity and Small Group Decision Making: Towards a social identity framework for studying the effects of task-related differences on dyads and groups*
2005-15: Sven Zebel: *Negative Associations: The Role of Identification in Group-Based Guilt*
2005-16: Eric Rietzschel: *From quantity to quality: Cognitive, motivational and social aspects of creative idea generation and selection*
2006-1: Maria Dijkstra: *Workplace Conflict and Individual Well-Being*
2006-2: Ruud Custers: *On the underlying mechanisms of nonconscious goal pursuit*
2006-3: Ellen Dreezens: *The missing link: the relationship between values and attitudes*
2006-4: Jacquelien van Stekelenburg: *Promoting or preventing social change. Instrumentality, identity, ideology and groupbased anger as motives of protest participation*
2006-5: Huadong Yang: *Siding in a conflict in China and in the Netherlands*
2006-6: Tomas Ståhl: *Determinants of Fairness-based and Favorability-based Reactions to Authorities' Decisions*
2006-7: Astrid Homan: *Harvesting the value in diversity: Examining the effects of diversity beliefs, cross-categorization, and superordinate identities on the functioning of diverse work groups*
2006-8: Saskia Schwinghammer: *The Self in Social Comparison*
2006-9: Carmen Carmona Rodríguez: *Inferior or Superior: Social Comparison in Dutch and Spanish Organizations*

2006-10: Martijn van Zomeren: *Social-psychological paths to protest: An integrative perspective*
2007-1: Nils Jostmann: *When the going gets tough… How action versus state orientation moderates the impact of situational demands on cognition, affect, and behavior*
2007-2: Belle Derks: *Social identity threat and performance motivation: The interplay between ingroup and outgroup domains*
2007-3: Helma van den Berg: *Feeling and Thinking in Attitudes*
2007-4: Karin C.A. Bongers: *You can't always get what you want! Consequences of success and failure to attain unconscious goals*
2007-5: Lotte Scholten: *Motivation matters: Motivated information processing in group and individual decision-making*
2007-6: Debra Trampe: *Social influence: Social comparison, construal, and persuasion processes*
2007-7: Clemens Wenneker: *Processes underlying biased language use*
2007-8: Yaël de Liver: *Ambivalence: on the how and when of attitudinal conflict*
2007-9: Erik de Kwaadsteniet: *Uncertainty in social dilemmas*
2007-10: Hugo Alberts: *Processes of self-control and ego depletion*
2007-11: Loran Nordgren: *Feeling is Believing: The Nature and Significance of the Hot/Cold Empathy Gap*
2007-12: Stefan Thomas Mol: *Crossing Borders with Personnel Selection from expatriates to multicultural teams*
2007-13: Hilbrand Oldenhuis: *I know what they think about us: Metaperceptions and intergroup relations*
2007-14: Arnaud Wisman: *New Directions in Terror Management Theory*
2007-15: Gert Homsma: *Making Errors Worthwhile: Determinants of Constructive Error Handling*
2007-16: Elianne van Steenbergen: *Work-Family Facilitation: A Positive Psychological Perspective on Role Combination*
2007-17: Unna Danner: *By Force of Habit: On the Formation and Maintenance of Goal-Directed Habits*