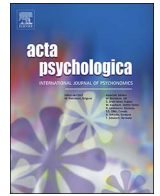




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An experimental investigation of breaking learnt habits with verbal implementation intentions

Aukje A.C. Verhoeven, Merel Kindt, Colene L. Zomer, Sanne de Wit*

Department of Clinical Psychology, University of Amsterdam, P.O. Box 15933, 1001 NK Amsterdam, The Netherlands

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ABSTRACT

The interplay between inflexible habits and flexible goal-directed control can be modelled in lab-settings using the slips-of-action task. In this task, participants are required to selectively respond to still-valuable outcomes while suppressing responding towards no-longer valuable outcomes, thereby overriding learned stimulus-response associations. Here we examined in the slips-of-action task whether learnt habits can be changed using a planning technique – so-called implementation intentions – whereby people instruct themselves to enact a certain behaviour (or not) in the presence of a specific critical stimulus. Such simple ‘if-then’ instructions have previously been shown to support behavioural change in real-life settings, possibly because people verbally create new stimulus-response associations. Across four experiments we manipulated the intrinsic value of the stimuli and outcomes in the slips-of-action task: abstract stimuli and outcomes (Experiment 1), snack food stimuli and outcomes (Experiment 2), or a combination of both types (Experiment 3–4). Implementation intentions improved the ability to suppress previously learnt responses towards no-longer-valuable *abstract* outcomes (Experiment 1 and 3). However, when snacks were used as outcomes (Experiment 2 and 4) no beneficial effect of implementation intentions versus goal intentions was observed. The slips-of-action task is thus sensitive to planning techniques under certain circumstances. Yet, the absence of effects when using snacks as outcomes implies the possible importance of its hedonic outcome value for implementation intentions' effectiveness, which warrants further investigation.

1. An experimental investigation of breaking the chains of habit with implementation intentions

Most of our behaviour is repeated daily in the same context, thereby creating the perfect conditions for the formation of habits (de Wit & Dickinson, 2009; Ouellette & Wood, 1998; Wood & Ruenger, 2015). Once such habits have been established, people become prone to perform these responses even when its outcome is no longer desired (de Wit & Dickinson, 2009). Such ‘action slips’ can also play a role in ‘bad habits’, such as unhealthy eating habits. To illustrate, when one is craving a savoury snack, initially it may be a deliberate decision to eat crisps. However, if one repeats this behaviour frequently in front of the television, the contextual cue of the television may come to trigger the behaviour automatically. As a result, one may reach for the crisps in the spur of the moment, even when the explicit intention is to eat more healthily. Indeed, diary studies have provided evidence demonstrating the role of automatic processes in eating behaviour (Verhoeven, Adriaanse, Evers, & de Ridder, 2012; Verplanken & Wood, 2006). To account for a gradual loss of behavioural flexibility with repetition,

dual-system theories have postulated a shifting balance between a goal-directed and a habitual system (de Wit & Dickinson, 2009; Dickinson, 1985). Initially, the goal-directed system enables people to flexibly select their actions based on their current desire for the anticipated outcome of an action. However, as a consequence of repetition, direct stimulus-response associations are reinforced in the habit system, which leads to efficient and fast behaviour, but eventually also to a loss of immediate sensitivity to changes in outcome values or goals.

To gain insight into the mechanisms that underlie the formation of habits, experimental models of habits are of crucial importance. In the present series of studies, we investigate a model that has been employed in many recent studies in controlled lab settings, namely the slips-of-action task (de Wit, Watson et al., 2012; Gillan et al., 2011; Sjoerds et al., 2013). The slips-of-action task experimentally models habitual behaviour and its insensitivity to outcome value resulting in action slips. In this computerized instrumental learning task, the goal of participants is to collect rewarding outcomes that are worth points and/or credits. Participants learn that after a certain stimulus, a specific response should be performed (pressing either a right or left key) in

* Corresponding author.

E-mail address: S.deWit@uva.nl (S. de Wit).

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order to gain a rewarding outcome. Initially, all of the different outcomes are valuable. However, in a subsequent phase, some of these outcomes are devalued, meaning that these will lead to subtraction of points. Hence, participants should selectively press for the outcomes that are still valuable and suppress the learned stimulus-response associations for devalued outcomes. In this way, the slips-of-action task models the balance between goal-directed behaviours performed in anticipation of specific outcomes and habitual responses induced directly by stimulus-response associations. This task is translated from outcome devaluation paradigms that have been used for over 30 years to investigate habits formation in animals (Adams, 1982; Adams & Dickinson, 1981).

The slips-of-action task holds promise as an experimental model of the balance between goal-directed and habitual control. It has already been used successfully to provide evidence for individual differences in how fast people form inflexible habits, which were related to measures of structural integrity of different brain networks in a structural MRI investigation by de Wit, Watson et al. (2012). Importantly, these same networks had previously been implicated in goal-directed and habitual control by functional MRI studies (ventromedial prefrontal cortex – caudate versus premotor cortex – posterior putamen; respectively) (de Wit, Corlett, Aitken, Dickinson, & Fletcher, 2009; Tricomi, Balleine, & O'Doherty, 2009). Furthermore, this task has been used to provide evidence for increased reliance on habits as reflected in action slips, for example in alcohol dependence (Sjoerds et al., 2013), drug addiction (Ersche et al., 2016), Tourette syndrome (Delorme et al., 2016), and obsessive-compulsive disorder (Gillan et al., 2011). Furthermore, similar behavioural deficits have been observed in people suffering from Parkinson's disease (de Wit, Barker, Dickinson, & Cools, 2011), but also in healthy aging (de Wit, van de Vijver, & Ridderinkhof, 2014).

In the present study, we aim to further investigate the validity of this experimental model of habitual behaviour by examining its sensitivity to a strategy that is known to influence habitual behaviour in everyday life, namely implementation intentions (Gollwitzer, 1999). Implementation intentions are concrete 'if-then' plans specifying when and how to perform a desired behaviour (Gollwitzer, 1993, 1999; Gollwitzer & Sheeran, 2006; Hagger et al., 2016). In contrast to goal intentions that describe a desired outcome (e.g., 'I intend to eat more healthily'), implementation intentions identify a critical situation and link this to a wanted action ('If I finished lunch, then I will take an apple'), thereby creating a strong association between the specified stimulus and the instrumental response (Webb & Sheeran, 2007). Implementation intentions have been shown to successfully promote new behaviours like vitamin pill intake (Sheeran & Orbell, 1999) or fruit and vegetable consumption (Wiedemann, Lippke, & Schwarzer, 2012), as well as changing existing unwanted habits, such as recycling used paper and plastic cups (Holland, Aarts, & Langendam, 2006) or changing unhealthy diets (Adriaanse, Vinkers, De Ridder, Hox, & De Wit, 2011; Verplanken & Faes, 1999). The effectiveness of this strategy has been reported among healthy populations and among clinical samples, including more effective planning to compose a CV in opiate addicts under withdrawal (Brandstätter, Lengfelder, & Gollwitzer, 2001), and improved performance on a go/no go task in patients suffering from schizophrenia as well as children with ADHD (Brandstätter et al., 2001; Gawrilow & Gollwitzer, 2008).

The effectiveness of implementation intentions has also been demonstrated in controlled lab settings, with a large body of literature including reports of improved performance on 'go/no-go' tasks (Brandstätter et al., 2001; Gawrilow & Gollwitzer, 2008), Stroop tasks (Webb & Sheeran, 2003), and task switch paradigms (Webb, Sheeran, & Luszczynska, 2009). Although these findings are promising, we argue that these tasks are not adequate experimental models of the balance between habitual and goal-directed control. In such tasks, participants are asked to respond to certain stimuli but to refrain from responding when the stimuli are accompanied with a directly presented no-go cue or a stop signal. Therefore, such tasks measure stimulus-

based performance. Crucially, performance in the slips-of-action task is concerned with inhibition based on the anticipated *outcomes* of actions. Rather than being explicitly told to which stimuli they should suppress responding, in the slips-of-action task, participants are informed to which outcomes they should direct their responses. Therefore, participants in the implementation intention condition have to actively formulate their own stimulus-based instructions on the basis of changes in the current desirability of different available outcomes. In so doing, the slips-of-action task more accurately models the translation of goals into specific implementation intentions that is required for effective planning in everyday life. In addition, as (control) participants who form goal intentions rather than implementation intentions focus on the anticipated outcomes, the adoption of goal intentions in this task more accurately reflects general goal-pursuit in daily life. Thus, with the slips-of-action task, it can be investigated in an experimental setting whether the translation of goals (based on present outcome values) to concrete if-then plans (stimulus-based responding) has an instant beneficial effect on performance.

To summarise, the present studies were designed to examine whether performance on slips-of-action task, a paradigm designed to experimentally investigate inflexible habitual behaviours, is sensitive to a planning technique that is known to change unwanted habits, namely implementation intentions (Gollwitzer, 1993, 1999). In four experiments, it was investigated whether performance on the slips-of-action task, demonstrated by responding more selectively towards valued rather than devalued outcomes, would be improved after formulating implementation intentions (translating suppression of responding towards no-longer-valued outcomes into direct stimulus-response associations) compared to goal intentions (concentrating on anticipated outcomes). The studies differed with respect to the intrinsic value of the stimuli and outcomes. Abstract symbols were used in the first study to allow for controlled testing with novel stimuli and outcomes. However, in order to generalise the findings to stimuli and outcomes that are more intrinsically relevant, the second experiment included food items. As the first and second study yielded different findings, the third and fourth study were conducted to disentangle the role of abstract symbols versus relevant food items either as stimuli or as outcomes for implementation intention 's effectiveness. Study three and four then, used food as stimuli and abstract outcomes, and vice versa.

2. Study 1

In Study 1, we aimed to examine whether the slips-of-action task would be sensitive to planning techniques. During the learning phase, participants were trained to press either right or left, depending on the abstract stimulus at the start of the trial. Correct responses were followed by different abstract symbols that were worth financial credits. During the subsequent test phase, participants were instructed that certain abstract outcomes would now lead to subtraction of financial credits from the total score while other outcomes were still valuable. To reach a maximum score, they should withhold their response when the stimuli associated with devalued outcomes were shown on the screen, while continuing to press upon seeing stimuli for still-valuable outcomes. Half of our participants were asked to form a goal intention concerning the *outcomes* they should no longer press for, while the other half was asked to form an implementation intention specifying to which *stimuli* they would no longer press. Furthermore, while half of our participants were asked to form such negation intentions, the other half were asked to form positive intentions regarding the still-valuable outcomes and their associated stimuli. Previous diary research into real-life habits has provided evidence for a possible adverse effect of negation implementation intentions (Adriaanse, van Oosten, de Ridder, de Wit, & Evers, 2011), and therefore, we aimed to examine whether positive intentions might have a more beneficial effect than negation intentions in the context of the slips-of-action task. Most importantly, however, we aimed to establish

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