Bas Verplanken *Editor*

The Psychology of Habit

Theory, Mechanisms, Change, and Contexts

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Preface

It is surprising how little research has been conducted on habits compared to other phenomena, given that habits govern much of what we are doing during our waking hours. My own interest in the concept started with the realisation that habits did not seem to sit comfortably with the expectancy-value and socio-cognitive models that dominate the attitude-behaviour domain in social psychology, which was the niche I grew up with as an academic. I was further inspired by Alice Eagly and Shelly Chaiken's seminal book *The psychology of attitudes*, published in 1993, in which they reviewed habit research and incorporated the concept in their composite model of the attitude-behaviour relation. These authors concluded that research on habits had not seen much progress due to a lack of proper measures.

Twenty-five years later, I am confident to say that progress *has* been made in habit research. This is evident in a variety of ways. Wendy Wood recently provided bibliographic evidence that after a long period of popularity during the first three decades of the twentieth century and a steady decline to an all-time low in the second half of that century, the use of the term *habit* increased sharply in the last 20 years among authors of popular and scientific books. Habit also appeared for the first time as an entry in the *Annual Review of Psychology*. And the concept is receiving more attention in contemporary textbooks. Thus, the present volume, *The psychology of habit*, can be considered as another testimony that progress has been made. The concept of habit has definitely (re)gained a position in the portfolio of researchers in a diverse array of domains. Importantly, much work has been done on theory, mechanisms, and measurement. This established a solid basis for further progress and adds value to the application of habit theory, for instance in the design of novel behaviour change strategies or policy making with respect to the many problems our societies are facing. I hope this book will contribute to that development. Of course, many questions remain to be answered, and this volume is not shying away from critical views and unfinished debates.

I am indebted first and foremost to all authors and co-authors of this volume. I am immensely proud to see this selection of distinguished researchers brought together. I particularly want to express my gratitude to three scholars who have been highly significant on my journey of habit research over the past 25 years: Henk Aarts, Sheina Orbell, and Wendy Wood. I thank all authors who have been so kind to review chapters, and Fiona Gillison, Eve Legrand, Caitlin Lloyd, and Greg Maio, who served as external reviewers. I also thank Morgan Ryan of Springer for her support and confidence in this book project. And last but not least I thank my dear wife Nona for her love and support, which hugely contributed to making this book see the light of day.

Bath, UK Bas Verplanken
21 June 2018

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About the Editor

Bas Verplanken graduated and obtained his PhD at the University of Leiden, the Netherlands, where he worked as a research fellow and lecturer from 1980 to 1990. From 1990 to 1998 he was a lecturer and senior lecturer at the University of Nijmegen. From 1998 to 2006 he was a professor at the University of Tromsø, Norway. In 2006 he joined the University of Bath, where he was Head of Department of Psychology from 2010 to 2016. His research interests are in attitude-behaviour relations and change, applied in the domains of environmental, health, and consumer psychology. He has developed a special interest in habits. He published on a variety of topics, including risk perception, environmental concern, unhealthy eating, travel mode choice, values, self-esteem, body image, worrying, mindfulness, impulsive buying, behaviour change, and sustainable lifestyles. He served as an associate editor of the *British Journal of Social Psychology* and *Psychology and Health*.

Chapter 1
Introduction

Bas Verplanken

'There is no more miserable human being than one in whom nothing is habitual but indecision (…)'

—William James (1887, p. 447).

Imagine you are moving into a completely new environment, where you will live and work. Everything has to be (re)discovered: the best way to commute, where to do your shopping, how the local supermarket is organized, or how to socialise. It may not be easy, even simple things are an effort, and you may be confused, tired, or even annoyed at times: *for a little while you are living a life without habits*. After a while, some trying and error, and perhaps a few embarrassing mistakes, you find the best way to get to work, discover nice shops, navigate the supermarket efficiently, and find out that the coffee corner is where you make new friends. You learn what does and does not work, things begin to feel 'normal', and life starts 'flowing' again: you are developing new habits. And importantly, you feel good about having habits back again! This book is about those ubiquitous, yet elusive, behaviours.

The thought experiment above illustrates in a nutshell some important features of habits. Firstly, everyday life is full of them. In two diary studies, in which participants gave hourly accounts of their behaviour, Wendy Wood and colleagues documented that between a third and a half of what students were doing every day could be classified as things they did almost daily and usually in the same location (Wood, Quinn, & Kashy, 2002). These were mundane behaviours related to things like school work, entertainment, social interaction, or eating and drinking. Although this was a snapshot of everyday activities in students' lives, and acknowledging that there must be variation across populations and cultures, there is no reason to suspect that these findings do not generalize to other populations.

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Secondly, habits represent regularity. Habits are ways our neural networks 'remember' recurring contexts, including optimal responses to those contexts, which are thus triggered when we encounter them. One might see this as the way nature is dealing with its inherent chaos and impermanence. William James (1887), quoting the French psychologist and philosopher Léon Dumont, describes habits as imprints left in the nervous system, similarly to when water running down a slope leaves imprints in the sand. These imprints thus provide the pathways for later—more efficiently running—water streams. Dealing with regularity by forming habits thus frees up mental resources, which can be used to attend to other, arguably more important, stimuli or activities. Habits thus function much like cognitive schemas, which can be seen as energy saving devices (Macrae, Milne, & Bodenhausen, 1994), and thus make sense from an evolutionary perspective on the development of the human brain (e.g. Hodgson, 2009).

Thirdly, habits are contributing to our sense of continuity during waking hours. We experience habits as a natural flow of events, whereas in fact we are making thousands of small choices and decisions all the time, such as where to sit, how to move, where to go, what to take, where to look, or what to say. However, we do not experience these behaviours as anything like making decisions, unless we face an unexpected or important situation where we have to make a deliberate choice. At such moments the 'flow' stops, and we may experience 'making a choice'. This comes with heightened and focused attention and requires allocating mental resources to the task at hand. This explains why the protagonist in the thought experiment at the beginning of this chapter feels tired at the end of a day full of such choices. When habits are in place, there is no need for conscious deliberation.

Finally, we develop habits for behaviours that work for us. When the protagonist 'felt good' when new habits were in place, this implied some form of reward. There is a vast literature on the role of rewards in animal and human learning and the development of habits, in particular in the tradition of the behaviourist school (e.g. Hull, 1943), including debates on the different roles of reinforcement (e.g. Guthrie, 1952; Skinner, 1938). While respectfully ignoring that vast literature here, it can be said that most habits develop to fulfil some goal (e.g. Aarts & Dijksterhuis, 2000; Wood & Neal, 2007). These goals can be practical, such as going from A to B in the most efficient way, but may also be hedonistic, such as the satisfaction of a chocolate muffin on your way to work. This points to two important caveats. The first is that the functionality of habits does not necessarily imply they are always good for us. While that chocolate muffin may taste good, it is not exactly contributing to a healthy diet, and, extrapolating from the individual to a population and from muffins to unhealthy eating in general, may be part of a major societal problem. In everyday language 'habit' is often used to denote unhealthy or undesirable behaviours. Thus, the phrase 'habits work for us' should be interpreted broadly, and include healthy, 'good' or desirable behaviours as well as unhealthy, 'bad', or undesirable ones. Secondly, while goals are often at the heart of habit formation, over time they may fade away, and all we are left with is an ingrained propensity to respond in a particular way to a specific cue (e.g. Wood & Neal, 2007; Wood & Rünger, 2016). This may become evident when you suddenly realise you are doing something for no good reason other than that you have always been doing it. This seems typical for many habits: when you ask a person why he is doing what he is doing, he is likely to make a misattribution and refer to some motivation (e.g. Wood & Rünger, 2016). However, if the behaviour is strongly habitual, the correct answer should probably be 'because this is what I always do'. Habituation thus implies shifting control over behaviour from motivation (willpower) to the behavioural context. This has major consequences for changing habitual behaviour (e.g. Verplanken & Wood, 2006).

Defining Habit

One might argue that psychologists' views on habit have not dramatically changed during its history from the late nineteenth century throughout to date. Nevertheless, two variants of habit definitions can be distinguished, which may not differ fundamentally in terms of the nature of the concept per se, but rather highlight different aspects of habits. Early writers described habit as an acquired *propensity*, which functions to adapt the organism to its environment (e.g. Dewey, 1922; James, 1887; Veblen, 1899/1922). For William James this propensity had a physical basis in the form of the brain's plasticity. His conception of habit formation involved pathways of neural discharges created by the sensations of muscular contractions. Gradually these pathways become ingrained, and are activated upon the mere perception of the habitual conditions under which they were formed. This does not only hold for simple acts, but also for more complex behaviours, which James described as 'concatenated discharges' in the nervous system. His description of pathways of discharges in the brain resonates with contemporary cognitive-neurological accounts of habits (e.g. Yin & Knowlton, 2006), and his interpretation of habitual action resembles what we now consider as 'automatically responding to habit cues' (e.g. Orbell & Verplanken, 2010; Wood & Neal, 2007). Thus, the Jamesian conception of habit as a memory-based propensity comes remarkably close to contemporary writers' views on habit (e.g. Aarts & Dijksterhuis, 2000; Gardner, 2015; Orbell & Verplanken, 2010; Verplanken, 2006; Verplanken & Aarts, 1999; Wood & Neal, 2007; Wood & Rünger, 2016).

A second definition of habit stresses the overt habitual action, that is, habits as repeated forms of conduct, or simply *repeated behaviour*. This variant is rooted in the behaviourist school, and was at the heart of the suite of early associationistic learning theories (e.g. Carr, 1931; Hull, 1943; Skinner, 1938; Thorndike, 1931; Watson, 1913), including Tolman's (1932) integration of Gestalt psychology and behaviourism. While that tradition has provided invaluable insights in mechanisms of habit formation, as well as powerful research paradigms, it led scholars to equate 'habit' with 'past behaviour'. This can be found in writings in applied social psychology, as well as other areas such as health, social medicine, or education, and may have stalled progress in habit theory for quite some time (e.g. Eagly & Chaiken, 1993). This is not to suggest that a history of behavioural repetition is not part of the habit concept: it is, both in a phenomenological and a conceptual sense. However, it is only part of the story; a habit proper is a memory-based cognitive associative entity which includes a history of behavioural repetition (e.g. Verplanken & Orbell, 2003). The latter distinguishes habits from other cognitive representations underlying automatic processes, such as schemas, first impressions, norms, or attributions.

The habit concept thus encompasses two key 'pillars'; a history of behavioural repetition and a cognitive representation of an association between cues and responses, which can instantly elicit behaviour upon confrontation with the habit context. The importance of automaticity in habitual responses, as contrasted to the deliberate motivation-driven processes such as implied by the dominant socio-cognitive models, was highlighted by the rise in popularity of dual-process models by the end of the last century (e.g. Chaiken & Trope, 1999). In his theory of interpersonal behaviour, Harry Triandis (1977) proposed two forces as direct antecedents of behaviour; intention and habit. Intentions were thought to be driven by attitudes, social factors, and affect, while habit is based on past behaviour. Importantly, in this model intention and habit have weights which vary between 0 and 1, and sum up to 1, thus suggesting that when the influence of intention is strong, the force of habit is weak, and vice versa. The weights represent 'facilitating factors'. For instance, a new situation increases the weight of intention, while time pressure increases the weight of habit. Two decades later, this model received strong empirical support in a seminal paper by Judith Ouellette and Wendy Wood (1998), who presented a dual-process account of ways in which past behaviour may influence future behaviour, a topic that has haunted the attitude-behaviour literature (cf., Ajzen, 2002). In a meta-analytic synthesis these authors demonstrated that past behaviour had a stronger impact on future behaviour when it had been frequently performed (i.e. become habitual), whereas behavioural intentions, representing more deliberate processes, were the strongest predictors of *in*frequent behaviours. Another demonstration of habit-related automaticity was provided by Henk Aarts and Ap Dijksterhuis (2000). These authors showed how goals are capable of automatically activating habitual responses. While the question whether goals are necessary ingredients for habits to operate was later debated (e.g. Wood & Neal, 2007), these studies provided an important testimony of the automaticity aspect of habits.

If we wish to arrive at a definition of habit, it should be informed by the early Jamesian views on habit, the learning theories in the behaviourist school, the cognitive revolution in the 1960s and 70s, and the vast work on implicit processes in the 1980s and 90s. Taken together, habits can thus be defined as *memory-based propensities to respond automatically to specific cues, which are acquired by the repetition of cue-specific behaviours in stable contexts*.

I do not restrict the habit concept to observable behaviour: we also have habits of thinking (e.g. Verplanken, Friborg, Wang, Trafimow, & Woolf, 2007). This is no new insight. For instance, Thorstein Veblen (1899/1922) distinguished habits of thinking from habits of action, and contended that the latter may shape the former. Even hard-core behaviourist John Watson (1913) talked about mental habits. While he obviously rejected the relevance of concepts such as reflection, consciousness or other mental processes, he accepted the notion of thinking habits, as he considered thought processes as motor behaviour in the speech musculature. Mental habits refer to the *way* thinking occurs, as distinct from the *content* of thinking. Habitual thinking may be useful, such as when solutions to recurrent problems easily come to mind, but may also be dysfunctional, such as having habitual negative self-thoughts (e.g. Verplanken et al., 2007; Watkins, 2008).

Theory is inextricably linked to measurement. In 1993, Alice Eagly and Shelly Chaiken wrote about the measurement of habit that '(…) the role of habit *per se* remains indeterminate (…) because of the difficulty of designing adequate measures of habit' (p. 181). This quote has always inspired me to be concerned with the measurement issue. When the thinking about habit moved on from equating habit with past behaviour to the contemporary views, such as represented by the two 'pillars' of habit, this opened the way for a suite of new, theory-informed, measurement instruments, such as Frequency-in-Context measures (e.g. Wood et al., 2002), the Self-Report Habit Index (SRHI; Verplanken & Orbell, 2003), and the Slips-of-Action paradigm (de Wit et al., 2012). Frequency-in-Context measures focus on recurring responses to habit cues; the SRHI relies on individuals' experiences of repetition and automaticity; and the Slips-of-Action paradigm capitalizes on action slips which reveal the automaticity of habitual responses.

Before I turn to the contents of this book, it may be insightful to position habits amongst other mental processes. I do this by mapping out processes which involve interactions between behaviour, thinking, and implicit systems (see Fig. 1.1). This is, of course, only a selection from the myriads of processes that form our mental world. However, this exercise points to where habit formation, the operation of existing habits, as well as mental habits occur, which thus may provide a 'road map' for the reader.

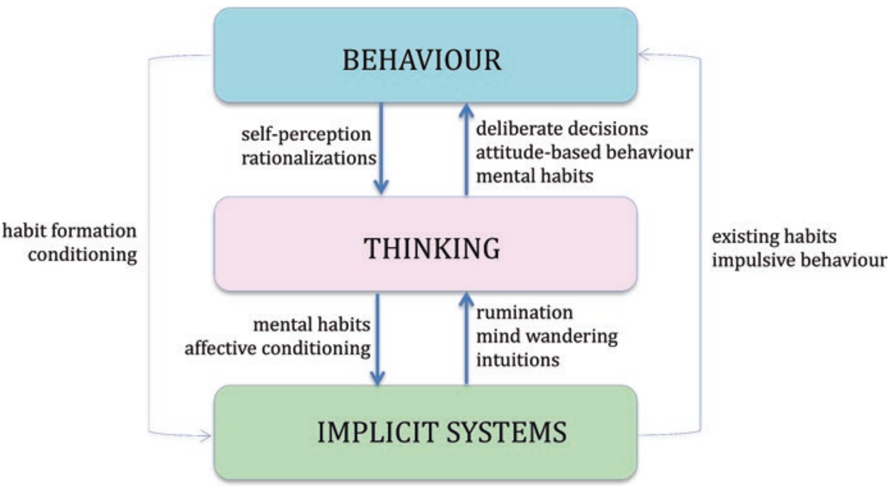

Fig. 1.1 Dynamic processes between behaviour, thinking, and implicit systems

What, How, Why?

This book aims to shed light on three questions about habits: '*what*', '*how*', and '*why*'. These questions are addressed in multiple ways in many of the chapters. The book has three sections. The first section, *Theory, measurement, and mechanisms*, digs deeper into the concept of habit, the way habit can be measured, and mechanisms involved in habitual action. It contains seven chapters. In Chap. 2, Asaf Mazar and Wendy Wood discuss the habit concept in more detail, including historic and modern conceptions, as well as some measurement issues. In addition to the role of goals, these authors also discuss the importance of context, that is, the habit cues which trigger habitual responses. Chapter 3 by Amanda Rebar, Benjamin Gardner, Ryan Rhodes, and Bas Verplanken is devoted to the measurement of habit. These authors discuss issues of reliability and validity, review available self-report measures, and reflect on implicit measures. They also highlight some controversies, such as the question whether people are able to self-report on their habits. In Chap. 4, Hans Marien, Ruud Custers, and Henk Aarts take a detailed look at the mechanisms involved in habits, from very simple acts to learning complex skills. They discuss characteristics of automaticity, and the roles of goals and motivation, including a critical discussion of the traditional outcome devaluation paradigm, in the light of future directions in habit research. In Chap. 5, Barbara Mullan and Elizaveta Novoradovskaya provide an analysis of behavioural complexity, and synthesize research in health, environmental, and social domains. These authors set up a two-dimensional framework defined by a one-step versus multistep dimension, and a hedonic versus distal benefit behavioural outcome dimension, respectively.

Chapters 6, 7 and 8 are dealing with habit paradigms in three different domains: physical activity, technology, and consumer behaviour, respectively. While sharing the basics of habits, each of these domains give them unique properties. In Chap. 6, Ryan Rhodes and Amanda Rebar highlight the complexity of physical activity such as exercising, breaking it down into components such as decision, preparation, and enactment, each of which may or may not be habitual. For instance, in order to establish a steady exercise regime it is the decision to exercise, and not so much the enactment of it, which needs to become habitual. These authors also discuss the role of intentions and self-control in the formation of physical activity habits. In Chap. 7, Joseph Bayer and Robert LaRose focus on the domain of information and technology habits, which permeate contemporary life. While the basic habit principles and mechanisms apply, some features are unique, such as the nature of cues (e.g. alerts), context (e.g. context *in*dependence of mobile phones) and rewards (e.g. social interaction). Also, technology habits may turn dysfunctional, if not pathological, in the form of internet addiction. Finally, in Chap. 8, Raphael Thomadsen and Seethu Seetharaman provide an account of consumer habits as these are treated in economics and quantitative marketing. In those literatures the habit concept appears as a special form of state dependence, the contingency of consumers' choices on their past consumption history. These authors also discuss the concept of variety seeking, which is often positioned as the antithesis of habit, and analyse the strategic implications variety seeking and habit may have, for instance on product pricing.

The second section of this book, *Breaking and creating habits,* contains nine chapters focused on change. Habits have two faces. On the one hand, we all know that habits are hard to change. If behaviour is strongly habitual, the traditional ‘teaching and preaching’ approach to behaviour change is challenging, to use a British understatement. The flipside of a habit is that the very features that make habits resistant to change, we would like new, desired, behaviours to acquire. Habit is thus an undervalued concept in behaviour change interventions; these often stop (i.e. accomplishing behaviour change), when more work needs to be done in order to retain the new behaviour and prevent relapses. Habit formation thus should be an important intervention goal. Chapters 9–12 focus on mechanisms, models, and paradigms related to habit change, while Chapters 13–17 focus on habit change in specific domains, namely health, psychopathology, and addiction, respectively.

In Chap. 9, Raymond Miltenberger and Claire Spieler start off this section by focusing on ‘the small’; modifying simple, involuntary, but often disturbing, habits such as nail biting, hair pulling, or using non-functional words, such as ‘like’ or ‘uh’. The authors describe habit reversal interventions as an effective way of breaking such habits, which involve techniques such as awareness training, competing response practice, habit control motivation, and generalization training. Chapter 10 focuses on the use of implementation intentions to break habits. Implementation intentions have been heralded as effective self-regulation tools for behaviour change. Marieke Adriaanse and Aukje Verhoeven provide an overview of work demonstrating the usefulness of implementation intentions for breaking unwanted habits and creating desired replacements, and describe mechanisms underlying these effects. However, while implementation intentions have been found an effective self-regulation tool, it is not a magic bullet. The authors point out boundary conditions when implementation intentions are used ‘in the wild’, and provide practical advice how to use them optimally. In Chap. 11, Bas Verplanken, Deborah Roy, and Lorraine Whitmarsh explore the Habit Discontinuity Hypothesis. If habits depend on context cues, when individuals undergo a life course change which disrupt such contexts or when contexts change, they can no longer rely on their habits. The Habit Discontinuity Hypothesis states that in those circumstances behaviour change interventions may be more effective. The authors review available evidence for the hypothesis, and discuss mechanisms that may drive habit discontinuity effects. In Chap. 12, Benjamin Gardner and Phillippa Lally focus on habit formation. While learning processes have been extensively researched in the behaviourist tradition, the formation of habits has received relatively little attention in the contemporary habit literature. The authors present a stage model of habit formation, and review research that support this model. The model thus provides a tool to identify facilitating factors and barriers to habit formation.

In the remaining set of five chapters in this section, Dominika Kwasnicka, Beatrice Konrad, Ian Kronish, and Karina Davidson describe in Chap. 13 a methodology of delivering personalised behaviour change interventions aimed at improving health conditions. This ‘N-of-1’ paradigm involves within-person repetitive measurements or observations, which thus may be used to capitalize on personal circumstances and drivers of behaviour. Such an approach provides unique opportunities to study habit formation and change. In Chap. 14, Sebastian Potthoff, Nicola McCleary, Falko Sniehotta, and Justin Presseau focus on habits amongst health care professionals. While these individuals have habits like any other individual (e.g. hygiene), some habits are narrowly defined by their specific profession, such as a doctor making fast, seemingly intuitive, but highly accurate decisions. The authors present theoretical approaches of explaining health care professionals' repetitive behaviour under pressure, and discuss strategies to break and create habits. In Chap. 15, Ed Watkins, Matt Owens, and Lorna Cook contend that depressive rumination may be considered as a mental habit. This does not only make conceptual sense but also has practical implications for therapeutic interventions. Moreover, these authors review evidence that lifestyle habits such as eating and exercise play a role in preventing depression. This suggests that behavioural and mental habits may co-exist and interact, which provides exciting future research opportunities. In Chap. 16, Aukje Verhoeven and Sanne de Wit discuss the inflexibility that habits carry with them, which often contributes to psychopathological conditions, especially compulsive disorders, and addiction problems. These authors then discuss the use of implementation intentions in dealing with such mental disorders, and ways in which this technique might be integrated in cognitive behavioural therapy. The theme of addiction is again addressed in Chap. 17, where Inna Arnaudova, Hortensia Amaro, and John Monterosso focus on healthy habits which support the recovery from substance use addiction and prevent relapse. Recovery habit strategies involve utilize-breaking habits in the earlier phases, and building new, healthy, habits in later phases. The authors present results from a pilot study which assessed the role of habit in a '12-step' program, which is a popular self-organized peer-support program on substance addiction, and discuss habit in the context of cognitive behavioural therapy and mindfulness-based relapse prevention.

In the third section of this book, '*Critical questions and prospects,*' we take a step back, and adopt a more critical mind-set, while also focusing on unresolved issues and topics that deserve future attention. Is what we think is a habit, always a habit? In Chap. 18, Lee Hogarth provides a critical review of animal and human studies of a habit account of drug dependence. This author contends that the standard outcome devaluation paradigm, which assesses the operation of habit versus goal-directed control, is not a viable paradigm to support a habit theory of drug addiction. Rather, evidence is provided to support the notion that drug dependence is driven by excessive goal-directed choice. The question 'is it always a habit' returns in the following two chapters. Ailsa Russell and Mark Brosnan in Chap. 19 discuss repetitive behaviours in autism (i.e. lower-order sensory motor repetitions and higher-order conceptual mental repetitions). After a comprehensive description of repetitive behaviours in autists, the authors discuss these behaviours in terms of habit characteristics. This discussion yields interesting questions for the autism domain, and provides input for a framework for change. The discussion also poses the question whether autism-related repetitive behaviours can be qualified as habits, and if so, what type. Chapter 20 asks the 'is-it-always-a-habit' question with respect to mind wandering, an activity familiar to most of us. Claire Zedelius, Madeleine Gross, and Jonathan Schooler map mind wandering onto the key features of habit. Thus, mind wandering qualifies as a mental habit in some respects but not in others. The authors also discuss individual differences in mind wandering habit, as well as maladaptive daydreaming as an extreme form of mind wandering habit. In Chap. 21, David Trafimow takes a critical stand towards the habit concept, in particular the automaticity of habits. This author poses 58 questions related to habit. Some are rhetorical, others are logically following philosophical propositions, point to obvious gaps in our thinking about habit, or question accepted models or insights. Many of these questions tap into current debates on habits, such as the question whether habits are in fact frequently represented intentions. I do hope that some questions will be regarded as 'inconvenient', as the chapter title promises: any field, including the domain of habit, needs inconvenient questions, and they cannot be critical enough, which is not only a message for the habit research community, but for all academic disciplines.

In the final Chap. 22, Sheina Orbell and Bas Verplanken take stock on the habit field. Based on the contributions in this book, these authors highlight three themes in particular, which are debated across the book and deserve further discussion and research; perspectives on the relationship of habit to motivation and goals; progress and prospects in habit measurement; the relationship of habit to concepts of willpower and self-control.

Habit Research in Action
This book not only aims to present a comprehensive 'state-of–the-art' overview of the habit area but also wants to provide practical information for those who (wish to) do research on habits. Therefore, except for Chaps. 2 and 22 each chapter contains a box labelled 'Habit research in Action'. These sections contain information on how to conduct habit research in the respective areas. This information is of any kind, and involves, for instance, instruments, paradigms, a typical study, or guidelines. I thus hope that this will be of use for students and researchers in the fascinating domain of habits.

References

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

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

Carr, H. A. (1931). The laws of association. *Psychological Review, 38*, 212–228.

Chaiken, S., & Trope, Y. (1999). *Dual-process theories in social psychology*. New York: The Guilford Press.

de Wit, S., Watson, P., Harsay, H. A., Cohen, M. X., van de Vijver, I., & Ridderinkhof, K. R. (2012). Corticostriatal connectivity underlies individual differences in the balance between habitual and goal-directed action control. *Journal of Neuroscience, 32*, 12066–12075.
Dewey, J. (1922). *Human nature and conduct: An introduction to social psychology*. New York: Henry Holt.
Eagly, A. H., & Chaiken, S. (1993). *The psychology of attitudes*. Fort Worth, TX: Hartcourt Brace Jovanovich.
Gardner, B. (2015). A review and analysis of the use of 'habit' in understanding, predicting and influencing health-related behavior. *Health Psychology Review, 9*, 277–295.
Guthrie, E. R. (1952). *The psychology of learning (Rev. ed)*. New York: Harper.
Hodgson, G. M. (2009). Choice, habit and evolution. *Journal of Evolutionary Economics, 20*, 1–18.
Hull, C. L. (1943). *Principles of behavior*. New York: Appleton.
James, W. (1887). The laws of habit. *The Popular Science Monthly, 31*, 433–451.
Macrae, C. N., Milne, A. B., & Bodenhausen, G. V. (1994). Stereotypes as energy-saving devices: A peek inside the cognitive toolbox. *Journal of Personality and Social Psychology, 66*, 37–47.
Orbell, S., & Verplanken, B. (2010). The automatic component of habit in health behavior: Habit as cue-contingent automaticity. *Health Psychology, 29*, 374–383.
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.
Skinner, B. F. (1938). *The behavior of organisms*. New York: Appleton.
Thorndike, E. L. (1931). *Human learning*. New York: Appleton.
Tolman, E. C. (1932). *Purposive behavior in animals and men*. New York: Appleton.
Triandis, H. C. (1977). *Interpersonal behavior*. Monterey, CA: Brooks/Cole.
Veblen, T. B. (1899/1922). *The theory of the leisure class. An economic study of institutions*. New York: B.W. Huebsch.
Verplanken, B. (2006). Beyond frequency: Habit as mental construct. *British Journal of Social Psychology, 45*, 639–656.
Verplanken, B., & Aarts, H. A. G. (1999). Habit, attitude, and planned behaviour: Is habit an empty construct or an interesting case of automaticity? *European Review of Social Psychology, 10*, 101–134.
Verplanken, B., Friborg, O., Wang, C. E., Trafimow, D., & Woolf, K. (2007). Mental habits: Metacognitive reflection on negative self-thinking. *Journal of Personality and Social Psychology, 92*, 526–541.
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 and Marketing, 25*, 90–103.
Watkins, E. R. (2008). Constructive and unconstructive repetitive thought. *Psychological Bulletin, 134*, 163–206.
Watson, J. B. (1913). Psychology as the behaviorist views it. *Psychological Review, 20*, 158–177.
Wood, W., & Neal, D. T. (2007). A new look at habits and the habit-goal interface. *Psychological Review, 114*, 843–863.
Wood, W., Quinn, J. M., & Kashy, D. A. (2002). Habits in everyday life: Thought, emotion, and action. *Journal of Personality and Social Psychology, 83*, 1281–1297.
Wood, W., & Rünger, D. (2016). Psychology of habit. *Annual Review of Psychology, 67*, 289–314.
Yin, H. H., & Knowlton, B. J. (2006). The role of the basal ganglia in habit formation. *Nature Reviews Neuroscience, 7*, 464–476.

Part I
Theory, Measurement, and Mechanisms

Chapter 2
Defining Habit in Psychology

Asaf Mazar and Wendy Wood

We've all said, "I can't help it, it's just a habit." Colloquially, habits can be convenient excuses for actions that are not ideal. Research into folk explanations shows that people tend to forgive others for misfortunate events when they could be produced by habit (Gershman, Gerstenberg, Baker, & Cushman, 2016). In one study, participants read a scenario about a problematic office door knob that locked when turned in the wrong direction. Despite being warned, a new worker haplessly did just that during his first day on the job, and locked a colleague into the office for several hours. But he wasn't always blamed. When the scenario noted that his door knobs at home worked in the same direction as the problem one in the office, participants were inclined to forgive. We understand, habits can run off without intention or thought. They are different from other actions. Without the excuse of doorknobs at home turning in that direction, the new worker was held more responsible for the mistake.

Folk psychology is self-serving when it comes to explaining our own habits. We no longer recognize the lack of intention and thought when it comes to our own behaviour. In fact, for beneficial actions, people are more likely to claim agency and responsibility for stronger habits. For example, students with strong habits to take the bus or strong habits to watch TV news reported being more certain of their intentions to do these things than students with weaker habits (Ji & Wood, 2007). Despite this conviction, strong habit participants did not act on their intentions during the next week. Instead, they continued to take the bus or watch the news in a habitual way, regardless of their intentions. For those with weak habits, however, more favorable intentions meant more frequent actions (see also Neal, Wood, Labrecque,

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& Lally, 2012). In a way, it makes sense to take credit for beneficial habits, given that they are aligned with intentions. However, intentions do not play a causal role in activating habits.

Folk psychology thus flexibly interprets habit intentionality. It excuses unwanted habits and claims responsibility for beneficial ones. It fails to reveal, however, the nature of habit. We know the feeling of making a decision, desiring something to happen, and controlling our actions so that it occurs. However, we can't introspect in the same way into the mechanics of habit performance. Like automaticity in general, habits are brought to mind by cognitive processes largely outside of conscious awareness. We can observe the action that results, but we are blind to the mechanism. Recent research is beginning to shed light on exactly what these processes involve.

Unraveling habit processes is the exciting premise of this edited volume. We begin to address this in the present chapter by outlining the history of habit in psychology, focusing especially on the various definitions of habit over the past 150 years of research. To provide an initial framework to the discussion, we note that most modern research begins with a conceptual definition of habits as *cue–response associations in memory that are acquired slowly through repetition of an action in a stable circumstance* (Gardner, 2015; Orbell & Verplanken, 2010; Wood & Rünger, 2016). As we will see, this definition is a relatively recent development in the history of habit, and it opens up many possibilities for habit measurement.

Historic Definitions of Habit

William James (1916/1983) was a big believer in habit. This is easily seen in his enthusiastic assessment that "99%, or, possibly, 99.9% of our activity is purely automatic and habitual, from our rising in the morning to our lying down each night. Our dressing and undressing, our eating and drinking, our greetings and partings…even most of the forms of our common *speech*, are things of a type so fixed by repetition as almost to be classed as reflex actions" (p. 48).

This enthusiasm set the stage for twentieth century research on habit. Early on, researchers highlighted the ways animals and humans learn stimulus–response associations (e.g. Thorndike, 1898). These ideas formed the foundations of behaviourism, especially radical behaviourism's infamous denial that thoughts and feelings guide action (e.g. Skinner, 1938). Although behaviourism took many forms, a common assumption was that stimuli, rewards, and other external forces guide repeated behaviour. (e.g. Hull, 1943).

This early heyday of habit research did not last long. Observing his rats run mazes, Tolman (1948) argued that they formed internal representations and cognitive maps. This theme resonated with psychology's developing interest in the mind. During the cognitive revolution in the mid-century, stimulus-response connections were replaced by information-processing models of goal pursuit (e.g. Miller, Galanter, & Pribram, 1960). In the cognitive view, people act by making decisions and pursuing goals. These ideas were encapsulated in an influential model of behaviour prediction—the theory of reasoned action/planned behaviour (Fishbein & Ajzen, 1975, 2011). All actions supposedly reflect people's intentions to act, which were assessed through their explicit ratings of behavioural goals and expectations.

Yet habit did not completely disappear. Triandis (1977, 1980) proposed an alternative model, the theory of interpersonal behaviour, which recognized that people could act out of habit, repeating past behaviour, as well as out of intention (which Triandis likened to self-instruction). The relative weighting of habit and intention depended on how often people had repeated a behaviour in the past. Well-established, overlearned behaviours were repeated without much input from conscious intentions. Triandis's ideas about the relation between habit and conscious decisions were surprisingly modern, predating dual systems models of information processing (Evans & Stanovich, 2013; Sherman, Gawronski, & Trope, 2014).

Even the cognitive revolution kept bumping up against habit. When performing a laboratory task in which the same stimuli were presented again and again, people seemed to just repeat the practiced response. They did not experience active control, they could perform secondary tasks, and they did not have to allocate attention (Shiffrin & Schneider, 1977). Apparently, they were guided by "a learned sequence of elements in long-term memory initiated by consistent stimuli" (Shiffrin & Schneider, 1977, p. 1). This habit-like responding was contrasted with controlled processing that involved "temporary activation of a sequence of elements" (p. 1). In this way, habit poked its nose under the cognitive tent with a new label, *automaticity*. As we will explain, automaticity proved to be a broad construct with many facets, only some of which correspond to habit. However, early observations of automaticity that emerged from repeated responding to consistent stimuli are closely aligned with habit formation (e.g. Gardner, 2015; Wood & Rünger, 2016).

Additional impetus for recognizing habit came from cognitive neuroscience. Research revealed that the procedural learning of habit activated somewhat different neural networks than other forms of implicit memory (Squire & Zola-Morgan, 1991). For habit learning, greater task repetition speeds performance, reduces thought and attention, and increases activation in certain brain regions (Knowlton & Patterson, 2016). Initially, task performance involves activation in a neural system known as the *associative loop*. This includes a part of the basal ganglia, the *caudate*, along with the midbrain and the *prefrontal cortex*, which is a brain region associated with self-control, planning, and abstract thought. With practice, activation increases in neural networks that include the *sensorimotor loop*, which connects the *putamen* of the basal ganglia with the *sensorimotor cortices* and parts of the midbrain (Tricomi, Balleine, & O'Doherty, 2009; Yin & Knowlton, 2006).

The multiple sources of evidence for habit in behaviour prediction, cognitive experiments, and neuroscience all pushed researchers in the same direction. Habit could no longer be ignored or replaced with other constructs. Recently, habit has been integrated with sophisticated models of deliberate, thoughtful action (Evans & Stanovich, 2013). In this synthesis, habit is one of many mechanisms that guide action. It is a category of *System 1*, defined broadly as cognitive processing that makes minimal demands on working memory. *System 2*, in contrast, draws on executive functions that can change or inhibit a faster, default, System 1 response.

The recognition of multiple types of processing is consistent with episode-sampling research tracking the role of thought in guiding action (Wood, Quinn, & Kashy, 2002). In studies in which participants reported every hour what they were thinking and doing, about 43% of everyday actions were habitual, in the sense that they were repeated almost every day in the same context and usually performed while people were thinking of something else. Although this estimate falls short of William James's (1916/1983) enthusiastic claims, he was correct in classifying a wide range of actions as habitual, including entertainment, work and study, social interactions, and standard routines of grooming, sleeping, and eating. As he anticipated, a great deal of everyday life is infused with habit automaticity.

Along with the emerging evidence of habitual responding in studies of behaviour prediction, cognitive psychology, and neuroscience, psychology has additional reason to embrace habit at this point in time. In the last decade, it is becoming clear that the standard approach to changing behaviour is falling short (Wood & Neal, 2016). People change their behaviour temporarily when they are motivated to do so by payment or other rewards (Mantzari et al., 2015). Increased knowledge and information can also change behaviour in the short term. Once behaviour change interventions end, however, people's motivation wanes, knowledge becomes less salient, and they revert back to what they were doing in the past. Psychology needs new approaches to understand and change behaviour.

Modern Definitions

The cue–response associations of habit memory form as part of instrumental learning, as people repeat behaviours and get rewards in a stable context (Gardner, 2015; Wood & Rünger, 2016). At first, people might act on their intentions, trying to achieve a goal or attain a desired outcome. As they repeat actions, stable elements in the performance context become associated with the behaviour. Eventually, perception of those elements then can trigger the behaviour directly, without a need for a conscious goal representation. For example, a habit of snacking at work may begin as a goal-directed behaviour aimed to reduce hunger. Given sufficient repetition, context cues (for example, the sight of one's office) may come to activate the snacking behaviour automatically, even in the absence of hunger. Indeed, for people who snack frequently in similar contexts (but not people who snack frequently in varying contexts), intentions do not predict snacking behaviour (Danner, Aarts, & de Vries, 2008). Thus, habit formation is a process by which behavioural control shifts from goal dependence to context dependence. Indeed, a common approach for assessing habitual behaviour is measuring its dependence on context cues, along with its independence from goals (see "Habit Measurement" section below).

In this account, many habits begin with goal pursuit. This is one way that habits interface with goals (see also de Wit & Dickinson, 2009). Wood and Rünger (2016) outlined three ways that goals can be involved in habit performance. First, goals influence habit formation by driving people to repeat actions in a certain context. Thus, goals may energize habit formation by bringing about context-consistent repetition. Second, goals interact with habits by influencing the expression of habitual behaviour. Once habits are formed, habitual behaviours are activated in memory directly by context, regardless of goals. However, when people are sufficiently motivated, they might inhibit an unwanted habit, despite it being active in mind. Alternatively, positive motivation might increase energy to perform a desired habit. The final way that goals and habits interact is when people infer their goals from observing their own habitual behaviour, perhaps through a process similar to self-perception (Bem, 1972). Because people do not have conscious access to habit cuing, they may misattribute their own habits to their volition. This could happen for desired behaviours, when the action is attributed to intentions, as well as undesired behaviours, when the action is inferred to be due to the pull of temptations and suppressed desires. This model is illustrated in Fig. 2.1.

Features of Habit Automaticity

Recent accounts of habit point to automaticity as a key defining feature (Gardner, Abraham, Lally, & de Bruijn, 2012; Orbell & Verplanken, 2010). Most analyses do not, however, specify what is meant by "automaticity." Automaticity is a broad, multidimensional construct that includes several correlated but independent features (Bargh, 2013; Moors & De Houwer, 2006). Automatic processes tend to be: goal-independent, in that they can function in the absence of, or even contrary to, intentions; unconscious, in that they can function without conscious awareness and may even be inaccessible to it; efficient, in that they do not require effortful

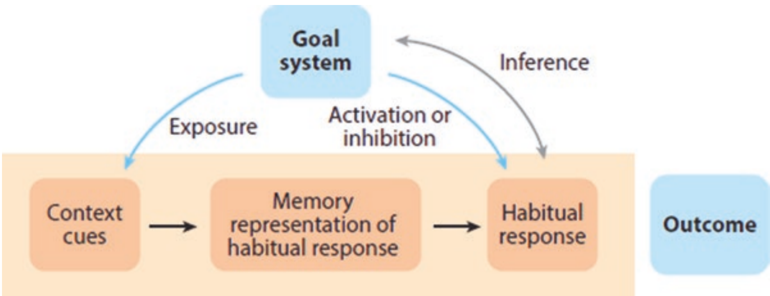

Fig. 2.1 Goal–habit interface model from Wood and Rünger (2016). Goals interact with habit by: (1) facilitating consistent exposure to context cues (seen in the arrow connecting the goal system and context cues), (2) influencing whether mental representations of habitual behaviour are acted on or inhibited (seen in the arrow going from the goal system to the habitual response), and (3) inferences of goals based on habitual behaviour (seen in the bidirectional arrow connecting the goal system and the habitual response)

attention or mental processing; fast; and perhaps most importantly for habits—stimulus driven, in that they can be cued directly by perception of elements in the environment (Moors & De Houwer, 2006).

Given that these various features of automaticity may not co-occur, the specific definition of automaticity adopted in any research usually depends on the topic of interest and the measure being used. Therefore, the most sensible approach for defining automaticity may be a polythetic one, whereby a process needs to show some but not all features of automaticity to be considered automatic to some degree. A classic definition that underlies many automaticity features is that automaticity involves single-step memory retrieval (Logan, 1988). Automaticity in this view means that, when a person perceives a stimulus, they directly retrieve the associated response from memory instead of effortfully calculating it. This echoes the idea of habit as direct retrieval of behaviour in response to a cue, with no need for mediation by reflective processes.

Given the multifaceted nature of automaticity, it is useful to dissociate habit from other forms of single-step retrieval. For example, habits differ from the types of automaticity typically studied in social psychology, including concept priming and automatic goal pursuit—a form of goal pursuit in which goals are activated and pursued without the need for conscious initiation and guidance. Automatic goal pursuit as well as concept priming are similar to habit in that they require little awareness or effortful attention (Aarts, 2007). However, these forms of automaticity differ from habit in that they assume spreading activation of semantic knowledge structures (Bargh, 2006). This stands in contrast to the direct cuing of a specific behaviour in habit (Wood & Rünger, 2016). For example, automatic goal pursuit assumes the activation of goals as hierarchical information structures in memory, which link goals to subordinate means for achieving them (Kruglanski et al., 2002). As such, the activation of a goal may result in diffuse activation of a variety of goal-related behaviours. Habits, on the other hand, involve a direct cue–behaviour association, in which context cues a specific well-learned response.

Context Dependence

Any recurring feature of a performance context could, potentially, function as a habit cue. Although some studies have found that internal states such as mood may cue habitual behaviour (Ji & Wood, 2007), most research to date has focused on observable context cues, including physical location, time of day, and preceding actions in a sequence (see Botvinick & Plaut, 2004; Ji & Wood, 2007). Given the human ability to create abstract cognitive representations, it is possible that these function as context cues as well, so that a habitual response becomes associated not with a concrete sensory cue, but rather with an abstract representation such as "at work" or "at a bar." Congruent with this idea, naturalistic research on smoking finds that smoking episodes are correlated with such abstract antecedents as "socializing" (Shiffman et al., 1997). Yet such a pattern is also consistent with the possibility that, by repeatedly smoking in a variety of specific social situations, smokers have learned to associate the behaviour with specific social contexts independently. Understanding the extent and conditions under which contexts generalize as cues to habits is an important direction for future habit research.

If context cues activate habitual responses, then a stable performance context should be important for habit formation. Repeating a behaviour in a stable context allows for a consistent pairing of environmental cues with a behaviour. However, repeating a behaviour in irregular contexts would not produce the context reliance that underlies habits. Congruent with this hypothesis, context stability has shown incremental validity in predicting the frequency with which people perform various types of behaviour, over and above measures of past frequency and intentions (Danner et al., 2008). Specifically, context stability moderates the relationship between the two latter variables and future behaviour: For behaviours performed in varying contexts, intentions tend to predict future behaviour better than past behaviour. For behaviours performed in a stable context, however, past behaviour is a stronger predictor (Ouellette & Wood, 1998).

The direct cuing of habit was anticipated by William James's (1890) principle of *ideomotor* action. He argued that thinking about an action is to some extent inseparable from—and therefore likely to lead to—performance of that action (at least when people are not monitoring their responses and intending to act otherwise). Direct cuing is supported by research using reaction time measures to assess the strength of cognitive links between contexts and responses. For example, Danner et al. (2008) measured strength of bicycling habits from the speed with which participants reported whether they would use a bike to reach various local destinations. Response speed predicted bicycling frequency over the next 4 weeks. This was especially true for participants with stronger associations (i.e. who were faster to respond). Suggesting that these participants were acting on habit, their intentions to ride did not predict frequency of bicycling. Intentions did matter, however, for participants with weaker habit associations, who cycled more when they intended to do so (see also Neal et al., 2012).

A context acquires the capacity to activate a response as people learn that certain actions get rewarded in that context. Neural reactions to rewards forge ties between the context and response in memory (Wood & Rünger, 2016). These associations drive even visual attention. Cues that have been associated with reward in the past draw attention automatically, even when they no longer predict reward and despite conscious attempts to ignore them (Anderson, 2016). Habit cues thus gain attention over other cues, potentially yielding a biased search for information, so that people with strong habits tend to seek information about their habitual behaviour but overlook information about alternatives (Verplanken, Aarts, & van Knippenberg, 1997).

If habits depend on context, then shifts in contexts should attenuate habitual responding. Indeed, research on *habit discontinuity* supports this hypothesis (Aldrich, Montgomery, & Wood, 2011; Thomas, Poortinga, & Sautkina, 2016; Verplanken & Roy, 2016; Verplanken, Walker, Davis, & Jurasek, 2008; Wood, Tam, & Witt, 2005). This literature uses changes in one's residence—to a new town, for example—as a natural experiment in context change. For example, among university employees who recently relocated, environmentally concerned employees commuted less frequently by car compared with employees who were not environmentally concerned (Verplanken et al., 2008). Among employees who had not recently relocated, however, environmental concern did not predict use of car over public transport. It thus seems that the relocation disrupted transportation habits, giving employees more intentional control over their transportation behaviour. Support for habit discontinuity comes from not only correlational designs but also experiments (e.g. Verplanken & Roy, 2016; see also Chap. 11 this volume). In both animals and humans, habits persist in the habitual context despite changes in reward value; in novel contexts, though, responses become sensitive to reward value, decreasing in frequency when no longer rewarding (Neal, Wood, Wu, & Kurlander, 2011; Thrailkill & Bouton, 2015).

Goal Independence

Context cues activate habitual behaviour directly, without mediation through goals or intentions. Therefore, one indicator of whether a behaviour is habitual is whether it persists even in the absence of goals. In animal models, a common way to assess habitual goal independence involves training rats to perform a behaviour for food. Rats that received extensive (but not moderate) training in that behaviour continued to perform it even after that food reward becomes aversive through pairing with a toxin (Adams, 1982; Dickinson, 1985). This suggests that habitual responses do not depend on representations of a desired outcome or goal, but instead are cued directly by context.

Research with human participants has similarly demonstrated that strong habits persist despite manipulations of outcome value. For example, persuasive appeals that changed preferences for soft drinks failed to change the drink choices of people with strong soft-drink habits (Itzchakov, Uziel, & Wood, 2018). Changes in monetary incentives failed to change response habits in a game, so that people continued to make a habitual choice even though it was no longer rewarded (Gillan, Otto, Phelps, & Daw, 2015). Eating a food to satiety did not deter participants from choosing that food when it was their habitual choice (Tricomi et al., 2009). People with strong habits to drink water in the dining commons or to bring their own water bottle were relatively unaffected by social norms to act otherwise (Mazar, Lieberman, Wood, & Itzchakov, in preparation). Across these studies, a wide range of habitual behaviours were robust to fluctuations in otherwise potent motivators. Habits are a powerful source of behavioural resistance.

Humans create complex, prospective mental representations, with goals that vary in immediacy, abstractness, and accessibility to consciousness. Nonetheless, correlational research has demonstrated that habits persist relatively independently of a variety of goal types, including ones that are simpler vs. more complex, abstract vs. concrete, and reported in personal terms vs. generic researcher-provided labels (Gardner, 2009; Ji & Wood, 2007; Ouellette & Wood, 1998; Verplanken, Aarts, van Knippenberg, & Moonen, 1998). Thus, variation in goals does not appear to explain habit persistence.

Other Features of Automaticity

Two defining features of habit are thus goal independence and cue dependence. Other aspects of automaticity are also useful for defining and measuring habit. First, habits are often inaccessible to conscious reflection. Although people may be aware of the outcome of habit from observing their own actions, they are normally not aware of its antecedents (i.e. triggering context cues) or the psychological mechanism that activates the response (the cue–behaviour association).

The unconscious nature of habit naturally lends itself to misattribution. As an automatic process, the habit cue–behaviour mechanism often goes unnoticed, and the mental content activated by habits may be misattributed to one's own goals and preferences (Loersch & Payne, 2011). Therefore, habits may be susceptible to a discrepancy between perceived and actual antecedents of behaviour, whereby diminishing intentional control is accompanied by increased perceived control. As already noted, strong habits were associated with an increased certainty of intentions, even though intentions did not predict behaviour for these individuals (Ji & Wood, 2007). In another study, participants with stronger running habits reported that their running was driven by their goals, although a cognitive association test revealed that goal priming did not activate running behaviours in mind (Neal et al., 2012). In addition, individual difference measures of self-control assess self-reports of people's ability to overcome distractions and effortfully pursue goals (see items such as "I am good at resisting temptation"; Tangney, Baumeister, & Boone, 2004). However, people who score high on these measures often attain goals by acting on habit rather than acting on willpower and effortful resistance (Galla & Duckworth, 2015). Therefore, it is possible that when people successfully self-regulate using habits, the obscurity of the process leads them to ascribe their success to more volitional sources.

Habit Measurement

Although most habit researchers agree on the theoretical definition of habits as automatic cue–response associations, operational definitions vary considerably. As a multifaceted construct, habit has been operationalized in various ways, with different research paradigms and tasks emphasizing different aspects of habit. In many circumstances, different habit measures yield congruent results and are highly correlated (e.g. Galla & Duckworth, 2015). In some cases, however, they differ in important ways, with some predicting behaviour more successfully than others (e.g. Labrecque & Wood, 2015). Given this diversity, it is no surprise that researchers are showing a surge of interest in the question of how best to measure habits (Gardner, 2015; Gardner & Tang, 2014; Gardner et al., 2012; Hagger, Rebar, Mullan, Lipp, & Chatzisarantis, 2015; see also Chap. 3, this volume).

Self–Report Measures

The most commonly used habit strength measures in social psychology are retrospective self-reports of frequency and experience of behaviour. Behaviour-frequency-and-context-stability measures combine a measure of performance frequency (how often is the behaviour performed) with a measure of context stability (i.e. how stable is the performance context; Ji & Wood, 2007). This habit measure assumes that behaviours repeated often in a stable context are likely to become habitual through basic learning mechanisms. Habit strength is calculated as the product of the frequency and context stability terms, so that behaviours that are performed both often and in a stable context are considered habitual (see Wood & Neal, 2009).

The foremost advantage of behavioural frequency and context stability measures is their substantial predictive power, arising in part from the strength of the past–future behaviour association (Labrecque & Wood, 2015). Indeed, Verplanken and Orbell (2003) found that across several studies, excluding behaviour frequency scale items from an alternative measure of habit (the Self Report Habit Index) slightly reduced its predictive validity. In addition, behavioural-frequency-and-context-stability measures are context-sensitive, and therefore tap the cue-dependent nature of habits. However, behavioural frequency and context stability measures have been criticized because they rely on past behaviour frequency, and potentially capture factors in addition to habit that might influence behaviour (Ajzen, 2002). Moreover, these measures assess the conditions that are conducive to habit formation, rather than the strength of the cue–response association itself.

The Self Report Habit Index, in contrast, is a self-report measure that directly assesses perceptions of performance repetition, automaticity, and self-identification with an action (Verplanken & Orbell, 2003). A subset of items from this scale—the Self Report Behavioral Automaticity Index—includes only four Self Report Habit Index items that specifically target automaticity (Gardner et al., 2012). Both measures have demonstrated reliability and predictive validity, with the Self Report Habit Index predicting behaviour somewhat better than the Self Report Behavioral Automaticity Index (Gardner et al., 2012; Verplanken & Orbell, 2003). By focusing on automaticity rather than behavioural frequency, the Self Report Behavioral Automaticity index (and to a lesser degree, the Self Report Habit Index) avoids the conflation of other factors inherent in measuring the past–future behaviour association. The main limitation of both measures is that they require participants to self-report on automaticity—a construct that, by its very definition, may resist conscious reflection (Hagger et al., 2015). As Sniehotta and Presseau (2012, p. 139) note: "a self-report likely reflects an inference about one's behaviour based on the consequences of the habit … rather than on a report of the habit itself." Another problem is that these scales were originally created without specifying a context (Verplanken & Orbell, 2003), and subsequent research has continued in this vein, failing to measure cue dependence (see Gardner, 2015). As such, the scales often do not isolate the context-dependent automaticity of habit. Instead, they may capture the effect of other automatic processes as well, such as the feelings of fluency that come from automated goal pursuit (Labrecque, Lee, & Wood, in preparation).

To identify context cues, respondents could self-report everyday triggers to their habitual behaviour (Gardner, 2015). Using this approach, Neal et al. (2012) solicited the locations in which participants typically ran (if they ever did), and individually tailored a reaction time task with this information. However, people often have only limited awareness of the cues that elicit their habitual behaviour. Self-reported cues may reflect lay theories of behaviour just as much as they reflect actual determinants. In evidence, both smokers and so-called emotional eaters tended to attribute past smoking and eating episodes to negative affect, even when researchers did not find that affect was associated with these behaviours (Adriaanse, Prinsen, de Witt Huberts, de Ridder, & Evers, 2016; Shiffman et al., 1997). Thus, further research is needed on how to identify the context cues that trigger habits.

Behavioural, Implicit, and Ecological Assessment Methods

Given the questions we raised about the validity of self-report methods, the most promising directions for future habit measurement may lie in alternative measures that assess (a) behavioural sensitivity to changes in goals and performance context or (b) implicit cognitive associations in ecologically valid contexts.

Behavioural sensitivity is represented in the basic pattern that strong habits persist even when that behaviour no longer achieves a desired goal. In addition, such responses should become goal-sensitive in novel contexts, where triggering cues are removed.

Reward devaluation paradigms assess goal independence by experimentally manipulating the value of a behaviour's outcome. In these paradigms, participants first learn to perform a behaviour to obtain a desirable outcome. The outcome is then devalued, either by reducing the value of the outcome, or the contingency between the behaviour and the outcome. For example, in one study, participants were trained to press a button for a food and then ate that food to satiety (Tricomi et al., 2009). Participants who received extensive training (but not moderate training) kept choosing the same food, despite being sated.

The advantage of outcome devaluation paradigms is that they successfully dissociate goal dependent from goal independent (habitual) repeated behaviours. However, a limitation of these paradigms is the assumption that behaviour is either habitual or goal-directed, so that weak goal-directed responding implies strong habitual responding (Watson & de Wit, 2018; see also Chaps. 4, 16 and 18 this volume). Behaviour that is goal independent need not necessarily be context dependent (Foerde, 2018). Indeed, outcome insensitivity in reward devaluation paradigms is associated more strongly with deficits in goal-directed control rather than a surplus in habitual control (see Watson & de Wit, 2018).

A possible solution may be paradigms that combine reward devaluation and context change, so that a behaviour is considered habitual if it is insensitive to outcome devaluation in the habitual context, but sensitive to outcome devaluation in a novel context (for example, see Thrailkill & Bouton, 2015). The advantage of these paradigms is that habits are assessed not only from the absence of goal dependence but also by the presence of context dependence. For example, Neal et al. (2011) gave either fresh or stale popcorn to movie goers in a cinema (a habitual context) or a conference room (a novel context). In the cinema, participants with strong popcorn-eating habits ate similar amounts of fresh and stale popcorn, despite their explicit dislike for the stale popcorn. Therefore, their behaviour was goal-independent. In the conference room setting, however, participants with both strong and weak habits acted in line with their goals and ate more fresh popcorn than stale.

Implicit measures of habit strength. Implicit measures can be broadly defined as measures in which the focal outcome is primarily produced by automatic processes (De Houwer, Teige-Mocigemba, Spruyt, & Moors, 2009). Such measures typically use reaction time as a marker of cognitive accessibility or the strength of cognitive associations. For example, Neal et al. (2012) asked runners for one-word descriptions of their goals for running (e.g. "health") as well as the context in which they usually ran (e.g. "park"). Participants then were primed with a word and indicated whether a second, subsequent letter string was a word or a non-word. As predicted, priming with context cues facilitated (speeded) recognition of running words for participants with strong (but not weak) running habits. Moreover, goals did not facilitate response to running words in strongly habitual runners, attesting to the goal-independent nature of habits.

To the best of our knowledge, two studies to date have used reaction time habit strength measures as predictors. The first (Danner et al., 2008), found that a reaction time habit measure predicted future bicycle riding frequency (see Context Dependence section for more details). In a second study, Labrecque et al.'s (in preparation) participants learned a sequential computerized sushi-making task. To assess habit strength, participants saw a random step from the sequence and responded as quickly as possible with the appropriate following step. Faster responding indicated greater habit strength. In addition to this implicit measure, participants reported habit strength on a self-report measure (the Self Report Behavioral Automaticity Index; Gardner et al., 2012). In comparisons between the two measures, only reaction time, and not self-reported automaticity, predicted whether habits persisted despite changes in intentions. Furthermore, the reaction time and self-report measures were not correlated, suggesting the measures were tapping different constructs. All in all, the insights gained from this study point to the promise of measures that directly tap the strength of mental associations.

Ecological assessments. Ecological momentary assessment is a relatively unexplored but promising direction for implicit measures. Participants are prompted, often with mobile devices, to complete brief measures several times a day while going through their daily routine (Stone, Shiffman, & DeVries, 1999; Wood et al., 2002). Ecological momentary assessment can include implicit measures along with self-report ratings. The potential is to evaluate context triggers while participants are in a habitual setting. Although some researchers have suggested that implicit measures are impractical in non-laboratory settings (Gardner, 2015), a number of studies have already reliably administered implicit measures online or on mobile devices (see Marhe, Waters, van de Wetering, & Franken, 2013; Sabin, Marini, & Nosek, 2012; Waters, Marhe, & Franken, 2012). Administering implicit measures in ecological contexts, although technically demanding to implement, offers an exciting new pathway for habit research.

Conclusions

It seems that lay perceptions of habit are quite close to scientific understanding. People understand that habitual behaviour may be unintentional or even uncontrollable. As such, they recognize one of the key characteristics of habit—goal independence. Whether people intuitively understand that habits are directly cued by contexts remains to be seen. Although people may have a fairly accurate lay understanding of habit, they are not always able to distinguish habitual from goal-directed behaviour. The inaccessibility of the automatic habit cuing mechanism means that people tend to misinterpret habitual behaviour as arising from motivational processes, whether conscious intentions in the case of desirable behaviours, or appetitive impulses in the case of undesirable habits.

In research, a prominent issue is the gap between theoretical and operational definitions of habit. Despite increased interest in habit measurement, operational definitions of habit still lag behind theoretical understanding. An overwhelming majority of studies to date use retrospective self-reports to assess habit strength, and many do not assess context dependence or repetition history—primary distinguishing features of habit automaticity. Although there is yet no accepted "gold standard" criterion against which to compare habit measures, habit research to date suggests two main predictions which should apply for valid habit measures. First, habits should be insensitive to changes to the behaviour's expected outcome. Second, habits should be sensitive to differences in context.

Two promising methods for future habit research are implicit measures and ecologically assessed behavioural sensitivity to changes in goals and context. Implicit measures afford considerable construct validity in that they measure cognitive associations directly instead of inferring them from behaviour. Ecological momentary assessment can bolster implicit measures by assessing naturalistic context priming. Behavioural criteria of sensitivity to changes in goals and context improve on mere frequency measures as benchmarks for distinguishing habitual responding from non-habitual responding. By integrating self-report, implicit, and behavioural measures, researchers can produce strong, valid conclusions about the way habits shape behaviour.

References

Aarts, H. (2007). Health and goal-directed behavior: The nonconscious regulation and motivation of goals and their pursuit. *Health Psychology Review, 1*(1), 53–82. https://doi.org/10.1080/17437190701485852

Adams, C. D. (1982). Variations in the sensitivity of instrumental responding to reinforcer devaluation. *The Quarterly Journal of Experimental Psychology Section B, 34*(2), 77–98. https://doi.org/10.1080/14640748208400878

Adriaanse, M. A., Prinsen, S., de Witt Huberts, J. C., de Ridder, D. T. D., & Evers, C. (2016). 'I ate too much so I must have been sad': Emotions as a confabulated reason for overeating. *Appetite, 103*, 318–323. https://doi.org/10.1016/j.appet.2016.04.028

Ajzen, I. (2002). Residual effects of past on later behavior: Habituation and reasoned action perspectives. *Personality and Social Psychology Review, 6*(2), 107–122. https://doi.org/10.1207/S15327957PSPR0602_02

Aldrich, J. H., Montgomery, J. M., & Wood, W. (2011). Turnout as a habit. *Political Behavior, 33*(4), 535–563. https://doi.org/10.1007/s11109-010-9148-3

Anderson, B. A. (2016). The attention habit: How reward learning shapes attentional selection. *Annals of the New York Academy of Sciences, 1369*, 24–39. https://doi.org/10.1111/nyas.12957

Bargh, J. A. (2006). What have we been priming all these years? On the development, mechanisms, and ecology of nonconscious social behavior. *European Journal of Social Psychology, 36*(2), 147–168. https://doi.org/10.1002/ejsp.336

Bargh, J. A. (2013). *Social psychology and the unconscious: The automaticity of higher mental processes*. Hove: Psychology Press.

Bem, D. J. (1972). Self-perception theory. *Advances in Experimental Social Psychology, 6*, 1–62. https://doi.org/10.1016/S0065-2601(08)60024-6

Botvinick, M., & Plaut, D. C. (2004). Doing without schema hierarchies: A recurrent connectionist approach to normal and impaired routine sequential action. *Psychological Review, 111*, 395–429.

Danner, U. N., Aarts, H., & de Vries, N. K. (2008). Habit vs. intention in the prediction of future behaviour: The role of frequency, context stability and mental accessibility of past behaviour. *British Journal of Social Psychology, 47*(2), 245–265. https://doi.org/10.1348/014466607X230876

De Houwer, J., Teige-Mocigemba, S., Spruyt, A., & Moors, A. (2009). Implicit measures: A normative analysis and review. *Psychological Bulletin, 135*(3), 347–368. https://doi.org/10.1037/a0014211

de Wit, S., & Dickinson, A. (2009). Associative theories of goal-directed behaviour: a case for animal–human translational models. *Psychological Research PRPF, 73*(4), 463–476. https://doi.org/10.1007/s00426-009-0230-6

Dickinson, A. (1985). Actions and habits: The development of behavioural autonomy. *Philosophical Transactions of the Royal Society of London. Series B, 308*(1135), 67–78. https://doi.org/10.1098/rstb.1985.0010

Evans, J. S. B., & Stanovich, K. E. (2013). Dual-process theories of higher cognition: Advancing the debate. *Perspectives on Psychological Science, 8*(3), 223–241.

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

Fishbein, M., & Ajzen, I. (2011). *Predicting and changing behavior: The reasoned action approach. Taylor & Francis*. New York: Psychology Press.

Foerde, K. (2018). What are habits and do they depend on the striatum? A view from the study of neuropsychological populations. *Current Opinion in Behavioral Sciences, 20*, 17–24. https://doi.org/10.1016/j.cobeha.2017.08.011

Galla, B. M., & Duckworth, A. L. (2015). More than resisting temptation: Beneficial habits mediate the relationship between self-control and positive life outcomes. *Journal of Personality and Social Psychology, 109*(3), 508–525. https://doi.org/10.1037/pspp0000026

Gardner, B. (2009). Modelling motivation and habit in stable travel mode contexts. *Transportation Research Part F: Traffic Psychology and Behaviour, 12*(1), 68–76. https://doi.org/10.1016/j.trf.2008.08.001

Gardner, B. (2015). A review and analysis of the use of 'habit' in understanding, predicting and influencing health-related behaviour. *Health Psychology Review, 9*(3), 277–295.

Gardner, B., Abraham, C., Lally, P., & de Bruijn, G.-J. (2012). Towards parsimony in habit measurement: Testing the convergent and predictive validity of an automaticity subscale of the self-report habit index. *The International Journal of Behavioral Nutrition and Physical Activity, 9*, 102. https://doi.org/10.1186/1479-5868-9-102

Gardner, B., & Tang, V. (2014). Reflecting on non-reflective action: An exploratory think-aloud study of self-report habit measures. *British Journal of Health Psychology, 19*, 258–273. https://doi.org/10.1111/bjhp.12060

Gershman, S. J., Gerstenberg, T., Baker, C. L., & Cushman, F. A. (2016). Plans, habits, and theory of mind. *PLoS One, 11*(9), e0162246. https://doi.org/10.1371/journal.pone.0162246
Gillan, C. M., Otto, A. R., Phelps, E. A., & Daw, N. D. (2015). Model-based learning protects against forming habits. *Cognitive, Affective & Behavioral Neuroscience, 15*(3), 523–536. https://doi.org/10.3758/s13415-015-0347-6
Hagger, M. S., Rebar, A. L., Mullan, B., Lipp, O. V., & Chatzisarantis, N. L. D. (2015). The subjective experience of habit captured by self-report indexes may lead to inaccuracies in the measurement of habitual action. *Health Psychology Review, 9*(3), 296–302. https://doi.org/10.1080/17437199.2014.959728
Hull, C. L. (1943). *Principles of behavior: An introduction to behavior theory*. Oxford: Appleton-Century.
Itzchakov, G., Uziel, L., & Wood, W. (2018). When attitudes and habits don't correspond: Self-control depletion increases persuasion but not behavior. *Journal of Experimental Social Psychology, 75*, 1–10. https://doi.org/10.1016/j.jesp.2017.10.011
James, W. (1890). *The principles of psychology* (Vol. 2). New York: Henry Holt.
James, W. (1916/1983). *Talks to teachers on psychology and to students on some of life's ideals*. Cambridge, MA: Harvard University Press.
Ji, M. F., & Wood, W. (2007). Purchase and consumption habits: Not necessarily what you intend. *Journal of Consumer Psychology (Lawrence Erlbaum Associates), 17*(4), 261–276. https://doi.org/10.1080/10577400701542403
Knowlton, B. J., & Patterson, T. K. (2016). Habit formation and the striatum. In *Behavioral neuroscience of learning and memory* (pp. 275–295). Cham: Springer. https://doi.org/10.1007/7854_2016_451
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: Academic Press. http://www.sciencedirect.com/science/article/pii/S0065260102800089
Labrecque, J. S., Lee, K., & Wood, W. (in preparation). *Overthinking habit*. Manuscript in preparation.
Labrecque, J. S., & Wood, W. (2015). What measures of habit strength to use? Comment on Gardner (2015). *Health Psychology Review, 9*(3), 303–310. https://doi.org/10.1080/17437199.2014.992030
Loersch, C., & Payne, B. K. (2011). The situated inference model: An integrative account of the effects of primes on perception, behavior, and motivation. *Perspectives on Psychological Science, 6*(3), 234–252. https://doi.org/10.1177/1745691611406921
Logan, G. D. (1988). Toward an instance theory of automatization. *Psychological Review, 95*(4), 492–527. https://doi.org/10.1037/0033-295X.95.4.492
Mantzari, E., Vogt, F., Shemilt, I., Wei, Y., Higgins, J. P. T., & Marteau, T. M. (2015). Personal financial incentives for changing habitual health-related behaviors: A systematic review and meta-analysis. *Preventive Medicine, 75*, 75–85. https://doi.org/10.1016/j.ypmed.2015.03.001
Marhe, R., Waters, A. J., van de Wetering, B. J. M., & Franken, I. H. A. (2013). Implicit and explicit drug-related cognitions during detoxification treatment are associated with drug relapse: An ecological momentary assessment study. *Journal of Consulting and Clinical Psychology, 81*(1), 1–12. https://doi.org/10.1037/a0030754
Mazar, A. S., Lieberman, A., Wood, W., & Itzchakov, G. (in preparation). Manuscript in preparation.
Miller, G. A., Galanter, E., & Pribram, K. H. (1960). *Plans and the structure of behavior*. New York: Holt.
Moors, A., & De Houwer, J. (2006). Automaticity: A theoretical and conceptual analysis. *Psychological Bulletin, 132*(2), 297–326. https://doi.org/10.1037/0033-2909.132.2.297
Neal, D. T., Wood, W., Labrecque, J. S., & Lally, P. (2012). How do habits guide behavior? Perceived and actual triggers of habits in daily life. *Journal of Experimental Social Psychology, 48*(2), 492–498. https://doi.org/10.1016/j.jesp.2011.10.011

Neal, D. T., Wood, W., Wu, M., & Kurlander, D. (2011). The pull of the past when do habits persist despite conflict with motives? *Personality and Social Psychology Bulletin, 37*(11), 1428–1437. https://doi.org/10.1177/0146167211419863

Orbell, S., & Verplanken, B. (2010). The automatic component of habit in health behavior: Habit as cue-contingent automaticity. *Health Psychology, 29*(4), 374–383. https://doi.org/10.1037/a0019596

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*(1), 54–74. https://doi.org/10.1037/0033-2909.124.1.54

Sabin, J. A., Marini, M., & Nosek, B. A. (2012). Implicit and explicit anti-fat Bias among a large sample of medical doctors by BMI, race/ethnicity and gender. *PLoS One, 7*(11), e48448. https://doi.org/10.1371/journal.pone.0048448

Sherman, J. W., Gawronski, B., & Trope, Y. (Eds.). (2014). *Dual-process theories of the social mind*. New York: Guilford Press.

Shiffman, S., Hufford, M., Hickcox, M., Paty, J. A., Gnys, M., & Kassel, J. D. (1997). Remember that? A comparison of real-time versus retrospective recall of smoking lapses. *Journal of Consulting and Clinical Psychology, 65*(2), 292.

Shiffrin, R. M., & Schneider, W. (1977). Controlled and automatic human information processing: II. Perceptual learning, automatic attending and a general theory. *Psychological Review, 84*(2), 127.

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

Sniehotta, F. F., & Presseau, J. (2012). The habitual use of the self-report habit index. *Annals of Behavioral Medicine, 43*(1), 139–140. author reply 141-2. https://doi.org/10.1007/s12160-011-9305-x

Squire, L. R., & Zola-Morgan, S. (1991). The medial temporal lobe memory system. *Science, 253*(5026), 1380–1386. https://doi.org/10.1126/science.1896849

Stone, A. A., Shiffman, S. S., & DeVries, M. W. (1999). Ecological momentary assessment. In D. Kahneman, E. Diener, & N. Schwarz (Eds.), *Well-being: The foundations of hedonic psychology* (pp. 26–39). New York: Russell Sage Foundation.

Tangney, J. P., Baumeister, R. F., & Boone, A. L. (2004). High self-control predicts good adjustment, less pathology, better grades, and interpersonal success. *Journal of Personality, 72*(2), 271–324. https://doi.org/10.1111/j.0022-3506.2004.00263.x

Thomas, G. O., Poortinga, W., & Sautkina, E. (2016). Habit discontinuity, self-activation, and the diminishing influence of context change: Evidence from the UK understanding society survey. *PLoS One, 11*(4), e0153490. https://doi.org/10.1371/journal.pone.0153490

Thorndike, E. L. (1898). Animal intelligence: An experimental study of the associative processes in animals. *The Psychological Review: Monograph Supplements, 2*(4), i.

Thrailkill, E. A., & Bouton, M. E. (2015). Contextual control of instrumental actions and habits. *Journal of Experimental Psychology: Animal Learning and Cognition, 41*(1), 69–80. https://doi.org/10.1037/xan0000045

Tolman, E. C. (1948). Cognitive maps in rats and men. *Psychological Review, 55*(4), 189.

Triandis, H. C. (1977). *Interpersonal behavior*. Pacific Grove, CA: Brooks-Cole.

Triandis, H. C. (1980). Values, attitudes, and interpersonal behavior. *Nebraska Symposium on Motivation, 27*, 195–259.

Tricomi, E., Balleine, B. W., & O'Doherty, J. P. (2009). A specific role for posterior dorsolateral striatum in human habit learning. *European Journal of Neuroscience, 29*(11), 2225–2232. https://doi.org/10.1111/j.1460-9568.2009.06796.x

Verplanken, B., Aarts, H., & van Knippenberg, A. (1997). Habit, information acquisition, and the process of making travel mode choices. *European Journal of Social Psychology, 27*(5), 539–560. https://doi.org/10.1002/(SICI)1099-0992(199709/10)27:5<539::AID-EJSP831>3.0.CO;2-A

Verplanken, B., Aarts, H., van Knippenberg, A., & Moonen, A. (1998). Habit versus planned behavior: A field experiment. *British Journal of Social Psychology, 37*(1), 111–128. https://doi.org/10.1111/j.2044-8309.1998.tb01160.x

Verplanken, B., & Orbell, S. (2003). Reflections on past behavior: A self-report index of habit strength. *Journal of Applied Social Psychology, 33*(6), 1313–1330. https://doi.org/10.1111/j.1559-1816.2003.tb01951.x

Verplanken, B., & Roy, D. (2016). Empowering interventions to promote sustainable lifestyles: Testing the habit discontinuity hypothesis in a field experiment. *Journal of Environmental Psychology, 45*, 127–134. https://doi.org/10.1016/j.jenvp.2015.11.008

Verplanken, B., Walker, I., Davis, A., & Jurasek, M. (2008). Context change and travel mode choice: Combining the habit discontinuity and self-activation hypotheses. *Journal of Environmental Psychology, 28*(2), 121–127. https://doi.org/10.1016/j.jenvp.2007.10.005

Waters, A. J., Marhe, R., & Franken, I. H. A. (2012). Attentional bias to drug cues is elevated before and during temptations to use heroin and cocaine. *Psychopharmacology, 219*(3), 909–921. https://doi.org/10.1007/s00213-011-2424-z

Watson, P., & de Wit, S. (2018). Current limits of experimental research into habits and future directions. *Current Opinion in Behavioral Sciences, 20*, 33–39. https://doi.org/10.1016/j.cobeha.2017.09.012

Wood, W., & Neal, D. T. (2009). The habitual consumer. *Journal of Consumer Psychology, 19*, 579–592.

Wood, W., & Neal, D. T. (2016). Healthy through habit: Interventions for initiating & maintaining health behavior change. *Behavioral Science & Policy, 2*(1), 71–83. https://doi.org/10.1353/bsp.2016.0008

Wood, W., Quinn, J. M., & Kashy, D. A. (2002). Habits in everyday life: Thought, emotion, and action. *Journal of Personality and Social Psychology, 83*(6), 1281–1297. https://doi.org/10.1037/0022-3514.83.6.1281

Wood, W., & Rünger, D. (2016). Psychology of habit. *Annual Review of Psychology, 67*(1), 289–314. https://doi.org/10.1146/annurev-psych-122414-033417

Wood, W., Tam, L., & Witt, M. G. (2005). Changing circumstances, disrupting habits. *Journal of Personality and Social Psychology, 88*(6), 918–933. https://doi.org/10.1037/0022-3514.88.6.918

Yin, H. H., & Knowlton, B. J. (2006). The role of the basal ganglia in habit formation. *Nature Reviews Neuroscience, 7*(6), 464–476. https://doi.org/10.1038/nrn1919

Chapter 3
The Measurement of Habit

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Even small changes in people's day-to-day thoughts and behaviours could add up to massive benefits for the health and well-being of populations, if maintained long-term. Climate change could be reduced through changes in daily energy use behaviours (Kurz, Gardner, Verplanken, & Abraham, 2015). Healthcare costs and early mortality could substantially diminish with minor changes to diet (Kelly et al., 2009; O'Flaherty, Flores-Mateo, Nnoaham, Lloyd-Williams, & Capewell, 2012) and physical activity (Nocon et al., 2008; Pratt, Macera, & Wang, 2000). The need to promote long-term change has led many researchers to the study of habit.

In this chapter, we define *habit* as the process by which a person's behaviour is influenced from a prompt to act based on well-learned associations between cues and behaviours (Gardner, 2015a; Rebar, 2017; Wood & Neal, 2016; Wood & Rünger, 2016). *Habit* is the process that determines behaviour, and habitual *behaviour* is the output of that process (Rebar, Gardner, & Verplanken, 2018). Whereas the habit process is automatic and spontaneously elicited, habitual behaviour can be

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inhibited through exertions of self-control or other motivational influences, which suppress the translation of impulse into action (Gardner, 2015b). For example, people with strong habits to eat junk food when stressed will tend to act on their temptation. However, if there are internal or external influences also acting on their behaviour, say for example a goal to avoid junk food, with vigilant monitoring, they may be able to inhibit the behaviour (Quinn, Pascoe, Wood, & Neal, 2010).

Several areas of the habit field are subject to debate. Controversy surrounds whether people can be aware of their habits, how habit is distinct from behaviour frequency, and whether and how the influence of habit might be disentangled from that of other forms of motivation. At the core of these controversies are issues of measurement, specifically the construct validity of habit measures; that is, are existing measures adequate for capturing the habit process? This chapter aims to meet these challenges.

What Makes a Measure 'Good'?

A 'good' measure will produce scores that reflect the truest representation of the target construct as possible—it will have sound *construct validity* (Haynes, Richard, & Kubany, 1995; Messick, 1990). Establishing construct validity is a balancing act: the measure must be sufficiently broad to fully represent the focal construct, yet sufficiently narrow to limit the amount of irrelevant information captured (Kline, 2013). A simple formula for the construct validity for a measurement of habit is:

$$\text{Habit Measurement} = \text{True Habit} + \text{Error}$$

A 'good' habit measure consists of variability mostly attributable to *True Habit* with negligible variability attributable to *Error*. Figure 3.1 shows a Venn diagram reflective of the variability of *True Habit* and *Habit Measurement*. Ideally, these circles would overlap entirely, indicating that the measure perfectly represents *True Habit*. Realistically however, in addition to the desired overlap caused by the measure variability representing *True Habit* (measured construct-relevant variability), there will be aspects of *True Habit* that are not captured by the measure (unmeasured construct-relevant variability), and some variability that does not reflect *True Habit* (error). Construct validity is more than the degree of overlap of these circles though. It also reveals the degree to which unmeasured variability of *True Habit* and measured error is systematic. Some of the variability will be random, which can reduce measurement precision but is less troublesome than non-random (i.e. systematic) variability (Kline, 2013). The measure may systematically miss important aspects of *True Habit*, and may systematically capture something other than *True Habit*. That would be akin to stepping on a scale and discovering it had weighed everything except your right arm (unmeasured variability) and had added the weight of a tree stump (error). Establishing construct validity depends on being able to operationalize *True Habit*.

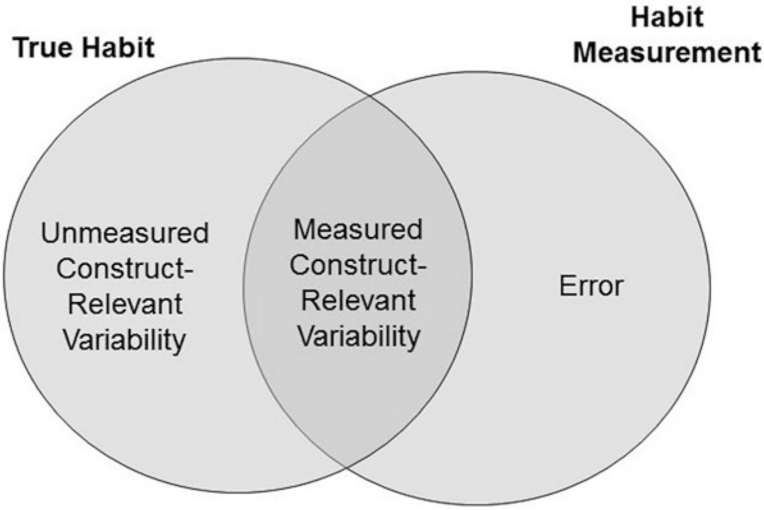

Fig. 3.1 A Venn diagram depicting variability of *True Habit* (i.e. the targeted construct), and error, and the overlap which is captured in the habit measurement (labelled *Measured-Construct Relevant Variability*)

It is easy to determine construct validity when measurements can be compared to an observable 'true' construct or gold standard measurement, because error is simply what is left after accounting for the true value (i.e. criterion-related validity; Messick, 1990). For example, any difference between step count recorded by a pedometer and an observed step count is likely error. However, *True Habit* is unobservable, and there is no gold standard measure.

Construct validity can alternatively be determined by establishing how measures perform inferentially in light of theoretical propositions. *Predictive validity* relates to the extent to which the score predicts constructs as put forth by theory. *Discriminant* and *convergent validity* refer to the extent to which the score is associated with constructs that theory would propose it be distinct from and related to, respectively (Messick, 1990). It is also important to consider how scores might be expected to change over time. *Reliability* is the degree to which the stability of observed scores conforms to theory (Kline, 2013).

Table 3.1 summarizes indicators of validity that we would anticipate from 'good' habit measures. These represent recommendations as opposed to steadfast rules, because habit theory will evolve alongside measurement advances. Additionally, these criteria are the most pertinent to the current state of the habit domain, but are not comprehensive. For example, as the field advances, consideration may be needed for the structural validity of habit (e.g. whether there are separable elements of habit) (Haynes et al., 1995; Messick, 1990).

Table 3.1 Summary of validity indicators of a 'good' measure of habit

Validity indicator	Description	Good habit measures should…
Predictive	Predicts outcome as put forth by theory	…predict future behaviour, with instigation habit predicting frequency
Convergent	Associated with theoretically related constructs	…be positively associated with other indicators of habit and inversely associated with information processes of alternative behavioural response possibilities
Discriminant	Distinct from other constructs	…be distinct from other non-habit-related automatic and reflective constructs
Reliability	Stability over time is aligned with theory	…be responsive to gradual change, but show minimal assessment-to-assessment fluctuation in the absence of true change

Predictive Validity

While it is possible for the habit process to be overridden prior to its manifestation in behaviour (Quinn et al., 2010), habit is expected to make a behaviour more likely to occur in situations in which it has been performed previously. Thus, in such settings, habit measurements should reliably predict future behaviour, as revealed by aggregated behavioural frequency over time (Rebar et al., 2018; Wood & Rünger, 2016). Most habit theory puts forth that it is the *frequency* of behaviour that should be predicted by habit, as opposed to the *duration* or persistence. However, recent theory advancements in distinctions of types of habit extend on this prediction in important ways.

Researchers are beginning to identify distinct roles that habit can play in any one behaviour, with distinctions being drawn between preparation versus performance, and instigation versus execution, of a behaviour (Gardner, Phillips, & Judah, 2016; Kaushal, Rhodes, Meldrum, & Spence, 2017; Phillips & Gardner, 2016). Consider the habit of exercising in the gym, for example. Habit may facilitate the gym-based exercise episode through preparatory actions; for example, habitually packing a gym bag in the evening permits an exercise session the following day. This has been termed *preparation habit* (Kaushal et al., 2017). Additionally, habit may generate an urge to go to the gym upon encountering a cue (e.g. lunch break), thus triggering the person to begin a 'gym-going' episode, bypassing any reflective deliberation over whether or not to engage in alternative activities (e.g. Verplanken, Aarts, & Van Knippenberg, 1997). This has been termed *habitual instigation* (Gardner et al., 2016; Phillips & Gardner, 2016). Exercising in the gym may also be thought of as habitual where habit facilitates progression through the sub-actions that make up an episode of exercising in the gym. For example, completing a workout on the treadmill may generate the urge to move to lifting weights, without any reflective consideration of whether to continue or end the exercise session. This has been termed *habitual execution* (Gardner et al., 2016; Phillips & Gardner, 2016).

These theoretical distinctions generate more precise forecasts regarding which aspects of future behaviour we can expect to be predicted by good habit measures.

Habitual preparation or instigation, but not necessarily habitual execution, should predict behavioural frequency (Gardner et al., 2016; Kaushal et al., 2017; Phillips & Gardner, 2016; Rhodes & Rebar, this volume). Few theoretical predictions have been made about which, if any, aspect of behaviour should be predicted by habitual execution, but it is possible that strong habitual execution will align with a high degree of regularity or being highly scripted in the performance of the behaviour. For instance, world-class athletes often achieve success by executing pivotal actions in a rigid and unvarying way (Jackson & Baker, 2001).

In line with habit theory, there are important conditions that should impact the degree to which habit measures predict future behaviour. The influence of habit on behaviour is context-dependent, meaning that habit should have stronger impact on behaviour where the behaviour has been more frequently paired with the contextual cue (Lally, Van Jaarsveld, Potts, & Wardle, 2010; Wood, Quinn, & Kashy, 2002). Therefore, habit should be more predictive of future behaviour to the extent that the context cue is regularly experienced (Wood & Rünger, 2016). Additionally, the habit process will not be activated unless the triggering cue is present. Habit should therefore be less predictive of future behaviour if the context has been disrupted by the removal, if only temporarily, of the contextual cue (Verplanken, Walker, Davis, & Jurasek, 2008; Wood, Tam, & Witt, 2005). In summary, for a habit measure to show predictive validity, it should predict the aggregated frequency of future behaviour in the presence of the triggering cue.

Discriminant and Convergent Validity

While habit measurements will likely be associated with the extent to which the behaviour has previously been performed (i.e. past behavioural frequency), habit cannot be *equated with* behaviour frequency, for two reasons. First, an action can be frequently performed without being habitual (Ajzen, 2002; Gardner, 2012; Verplanken, 2006; Verplanken & Melkevik, 2008; Verplanken & Roy, 2016). A doctor may be frequently sending patients to the operation theater, but this (hopefully) is not a habit. Second, an action can be habitual yet infrequently performed, which is the case for many actions that occur on a yearly cycle, such as filling out annual tax forms. A habit measure should therefore discriminate habit from behavioural frequency.

Habit measures should also show discriminant validity from motivational constructs. Triandis (1980) proposed that as a habit forms, the intentionality of a behaviour is lessened. The notion that habit and intention are distinct influences on behaviour remains an important aspect of habit theory (Bagozzi & Yi, 1989; Ouellette & Wood, 1998; Verplanken & Aarts, 1999). Dual process models propose that two types of processes generate behaviour: automatic processes, which are uncontrollable, spontaneous, and unintentional (e.g. habit), and reflective processes, which are controllable, slow, and based on deliberation (e.g. intention) (e.g. Evans & Frankish, 2009; Friese, Hofmann, & Wiers, 2011; Strack & Deutsch, 2004). Most dual process models propose that the automatic processing system is always online, generating simple or well-learned behaviours quickly and efficiently without forethought, freeing our limited cognitive resources for investment in more cognitively involved tasks. The reflective processing system only interferes with the automatic system when we are willing and able to engage in more elaborate decision-making and have enough self-control to translate those decisions into deliberate action.

Based on dual process model premises, predictions have been generated that habit, as a more spontaneous process, is likely to override the influence of reflective intentions unless intentions are particularly strong (Triandis, 1980). Evidence of such an effect is mixed. Many studies have found that people with strong habits tend to act in line with their habits rather than intentions (de Bruijn, 2010; Gardner, de Bruijn, & Lally, 2011; Ji & Wood, 2007; Verplanken, Aarts, van Knippenberg, & Moonen, 1998), but such an effect may be inflated by methodological problems such as when intention and habit measures are strongly positively correlated (Gardner, 2015a; Rhodes & de Bruijn, 2013; Rhodes, de Bruijn, & Matheson, 2010). There are also contexts where habits contradict intentions. However, the few studies that investigated such conflicts found main effects of habit and intention, suggesting that both have unique influences on behaviour in such contexts (Gardner, Corbridge, & McGowan, 2015; Verplanken & Faes, 1999). The mixed literature in this area means that the proposed dominance of habit over intentions in regulating behaviour cannot be considered a measurement criterion.

At the very least, there is general theoretical agreement that habit is distinct from intention, which is important for establishing discriminant validity of habit. In most instances, habit will likely form on the basis of the repeated enactment of an initially intentional behaviour (Lally & Gardner, 2013), and may therefore show a correlation with intention, but habit cannot be equated with intention. Intentions should be sensitive to changes in expected outcomes, such that a person should stop intending to do an action that no longer achieves a valued goal, or that leads to aversive consequences (e.g. Ajzen, 1991). Yet, habit may continue to elicit behaviour despite devaluation of expected outcomes (e.g. Adams, 1982; Wood & Neal, 2007).

Reliability

It is crucial that good measures are responsive to true changes in habit over time, rather than error (Aldridge, Dovey, & Wade, 2017). Figure 3.2 depicts a scenario in which habit formation is tracked within-person across time (Gardner, Sheals, Wardle, & McGowan, 2014). Two types of change will likely prevail when measuring habit repeatedly: gradual change over time (e.g. formation, degradation) and fluctuations (e.g. assessment-to-assessment differences). Theory proposes that habits are resilient, given that the underlying cue–behaviour associations stored in procedural memory are resistant to extinction (Wood & Neal, 2016; Wood et al., 2005). Even when new habits are forming, traces of old habits can remain and influence behaviour (Walker, Thomas, & Verplanken, 2015). Therefore, in stable contexts, test–retest reliability of good habit measures should show little fluctuation. Even if no habitual behaviours are performed between assessments, the habit should still be

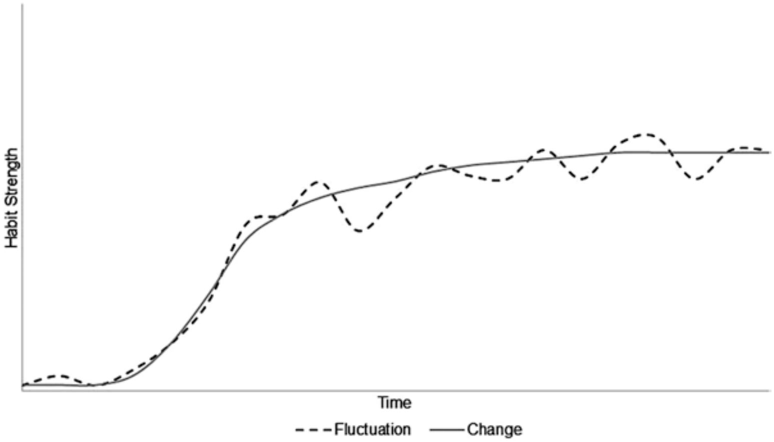

Fig. 3.2 A depiction of two types of change in measurement of habit strength over time, both of which may be the result of true change or measurement error: gradual change (e.g. *True Habit* formation, *Measurement Error* from response effects of repeated measurement) and between-assessment fluctuations (e.g. day-to-day changes in *True Habit*, *Measurement Error*)

reliably present, as revealed by action slips i.e. unintentional behaviour as a result of absent-mindedness (e.g. Verhoeven, Kindt, Zomer, & de Wit, 2018). When undergoing change, such as habit formation or degradation, these processes should be gradual (Aarts, Paulussen, & Schaalma, 1997; Lally et al., 2010; Walker et al., 2015). While certain circumstances may vary the stability or trajectory of test–retest habit reliability, such as whether habit is undergoing a change process (like formation or degradation) or how often cue–behaviour pairings are experienced, habit measures should generally show stability over time and be responsive to gradual change (both formation and degradation).

Considering Validity of Prevalent Habit Measures

Past Behaviour

Early habit research treated past behavioural frequency as a proxy for habit, as an unchallenged legacy from the behaviourist school (Bagozzi, 1981; Ronis, Yates, & Kirscht, 1989; Thompson, Higgins, & Howell, 1991; Triandis, 1980). As a habit measure, past behaviour shows strong predictive validity, typically strongly aligning with future behaviour (Aarts, Verplanken, & Knippenberg, 1998; Ouellette & Wood, 1998; Verplanken, 2010). Ouellette and Wood (1998) conducted a meta-analysis showing that the direct association between past and future behaviour was strongest for behaviours that were executed frequently and consistently in the same context. These findings align with conceptions of habit as predictive of future behaviour, albeit only under circumstances when cue–behaviour pairings are reliably present.

Obviously, past behaviour measures cannot meet the discriminant validity criterion that habit measures should diverge from past behavioural frequency. Moreover, past behaviour has no explanatory value; behaviour frequency alone cannot discriminate between habit and non-habitual influences that may regulate both past and future behaviour (Ajzen, 1991; Gardner, 2012; Verplanken, 2006). The statistical relationship between past and future behaviour that holds when motivational constructs are controlled represents a residual effect (Ajzen, 2002), with habit representing only one of a plethora of possible variables that might result in the past–future behaviour link (Rhodes & Courneya, 2003). There are stable and unknown influences on both past and future behaviour that are not captured by intentions or behavioural control. Such influences may or may not include habit. Thus, past behaviour measures do not exclusively reflect *True Habit* (Aarts & Dijksterhuis, 2000; Verplanken, 2010).

Frequency–In–Context Measures

Building on the idea that past behavioural frequency better captures habit for actions performed in stable settings, Wood et al. (2005) suggested that habit strength be measured using a combination of past behaviour frequency and context stability. Frequency-in-context measures estimate habit indirectly, based on the likelihood that habit has formed in conducive conditions (Gardner, 2015a); where a behaviour has been frequently enacted in an unchanging setting, it is most likely that habit has formed. Frequency-in-context measures thus represent the multiplicative product of behaviour frequency and context stability. Highest values denote highly frequent and context-consistent performances. Lower or moderate values denote a frequent but context-independent behaviour, an infrequent context-dependent behaviour, or a behaviour performed neither frequently nor in a consistent setting; none of these three forms of action are likely to be habitual.

Frequency-in-context measures have been shown to associate with a variety of future behaviours including purchasing fast food, watching TV news, and travel mode choices (Friedrichsmeier, Matthies, & Klöckner, 2013; Ji & Wood, 2007). Questions can, however, be raised about the assumption that frequent, context-dependent behaviour will *necessarily* become habitual. Verplanken (2006) showed that participants who performed an unfamiliar but simple task (counting occurrences of the word ‘she’ in a written text) reported stronger habit in completing the task than did participants who performed a more complex task (detecting references to mammals or movable objects), despite identical behavioural repetitions in an unchanging context. A study of the habit formation process pointed tentatively to a tendency for simpler actions (e.g. drinking water) to become habitual more quickly than complex actions (doing 50 sit-ups; Lally et al., 2010). Behavioural complexity may therefore be an important determinant of habit formation, casting doubt on the reliability of assuming habit formation based solely on behavioural frequency and context-dependence.

Frequency-in-context measures suffer from the same discriminant validity limitations outlined for behaviour-only measures by not isolating the habitual determinants of (context-dependent) behaviour from any other determinant that may have affected both past and future behaviour (Aarts & Dijksterhuis, 2000; Verplanken, 2010). There is also no evidence to suggest that the measure captures automatic processes, rather than reflective, intentional processes. It is reasonable to assume that some behaviours can be repeatedly performed in the same context, but be deliberate and controlled, such as doctors' prescription behaviour.

Self–Report Habit Index

Verplanken and Orbell (2003) proposed the 12-item Self-Report Habit Index (SRHI). Items follow a stem ('Behaviour X is something…') and require participants to reflect on the automaticity ('…I do automatically'), lack of awareness ('…I do without thinking'), lack of control ('…that would require effort not to do'), mental efficiency ('…I have no need to think about doing'), and repetition ('…I do frequently') of a given behaviour. The scale also suggests that habitual actions may become incorporated into the self-concept ('…that's typically "me"'). The SRHI addresses concerns about the extent to which people can reflect on automatic processes in two ways. First, it breaks down the habit concept into a number of facets (i.e. the experience of repetition, lack of awareness, lack of control, and mental efficiency). Secondly, participants do not reflect directly on habit itself, but rather the extent to which they experience the 'symptoms' of habitual responding (Orbell & Verplanken, 2015). The measure assumes that people can be aware *when reflecting on* their behaviour that they were *not* aware *when they performed* the behaviour. Such awareness can arise from observing the consequences of a habitual response—a habitual smoker who observes herself lighting a cigarette may quite accurately report a lack of awareness of doing so, which would be a fair indication of a habit (Orbell & Verplanken, 2010). The SRHI has been shown to predict behavioural frequency in a broad range of domains, including dietary consumption, physical activity, travel mode choice, and food hygiene (for reviews, see Gardner, 2015a; Gardner, Abraham, Lally, & de Bruijn, 2012; Gardner et al., 2011; Rebar et al., 2016). A meta-analysis of SRHI applications to dietary consumption and physical activity showed the SRHI to be robustly correlated with behaviour frequency (Gardner et al., 2011).

The few studies in which the SRHI was administered over time, in the absence of a habit formation or disruption intervention, suggest that the measure has good test–retest reliability. For instance, Verplanken and Orbell (2003) found a 0.91 test–retest correlation for bicycle use across 1 week, and Verplanken and Melkevik (2008) reported a 0.87 test–retest correlation for exercising across 1 month.

While not designed to be sensitive to habitual instigation or execution in particular, Gardner and colleagues have suggested that the wording of the SRHI ('Behaviour X is something…') can be modified to relate to habitual instigation (*The decision to* *exercise* is something…') or execution ('*Working out in the gym as my exercise this week* is something…') (Gardner et al., 2016). Kaushal et al. (2017) also showed it can be adapted to separate preparatory from behavioural performance habit. Factor analysis has demonstrated that the instigation-specific and execution-specific variant measure separate constructs, and subsequent predictive analyses showed the instigation variant to better predict behavioural frequency than did the execution variant (Gardner et al., 2016). Notably however, the instigation and original variants ('Behaviour X is something…') were found to assess the same variable, suggesting that the original SRHI may primarily capture habitual instigation rather than execution.

While the SRHI has been shown to have a single-factor structure, suggesting it assesses a unitary construct (Verplanken, Myrbakk, & Rudi, 2005), some have questioned the inclusion of self-identity (i.e. the item 'Behaviour X is something that is typically me') and behavioural frequency in the scale (Gardner et al., 2012; Rhodes et al., 2010). As Verplanken and Orbell (2003) acknowledge, an action may—but need not be—identity-relevant to be triggered habitually. When further identity items are added to the SRHI, identity emerges as a separate factor (Gardner et al., 2012). Additionally, some may interpret the item to represent the experience of frequency (Gardner & Tang, 2014). Recently, Verplanken and Sui (2018) provided evidence to suggest that there is variation between individuals in the degree to which habits reflect self-identity. They found that individuals for whom habits are strongly related to feelings of identity show stronger cognitive self-integration, higher self-esteem, and a stronger striving towards an ideal self.

Another debated aspect of the SRHI concerns its inclusion of behaviour frequency. Gardner et al. (2012) have argued that, where habit is used to predict behaviour, it is problematic to include an indicator of behavioural frequency in both the predictor (habit) and the outcome variable (behaviour) (e.g. Ajzen, 2002). Gardner et al. (2012) argue the mechanism by which habit triggers behaviour is automaticity, which is therefore the 'active ingredient' in the relationship between habit and behaviour. Gardner et al. (2012) proposed that, where habit is measured with the purpose of predicting future (or past) behaviour, or where the development of habit is tracked over time, only SRHI items relating to automaticity should be used. However, Orbell and Verplanken (2015) view behavioural frequency as a necessary component of a habit measure that must be retained within the SRHI, as actions may be automatic yet not habitual, such as reflexes or immediate but unique decisions. Verplanken and Orbell (2003) thus argue that past behaviour, as an indicator of repetition history, helps to discriminate habit-related and non-habit-related automaticity. Finally, Orbell and Verplanken (2015) emphasize that frequency-related items assess the *experience* of frequency and repetition. The SRHI is thus an experiential instrument.

Habit Index of Negative Thinking

A variant of the SRHI has been developed and tested as a measure of the habitual quality of negative self-thinking (i.e. the Habit Index of Negative Thinking; HINT; Verplanken, Friborg, Wang, Trafimow, & Woolf, 2007). While thinking has content (i.e. the thoughts proper), the HINT taps process aspects of that thinking—the repetitive and automatic nature of the thoughts—which can thus be considered as key aspects of mental habits (e.g. Watkins, 2008). The HINT has been found to predict outcome measures such as self-esteem, body esteem, and anxiety over and above the valence of the content of thinking (e.g. Verplanken & Fisher, 2014; Verplanken et al., 2007; Verplanken & Tangelder, 2011; Watkins, 2008).

Self–Report Behavioral Automaticity Index

The Self-Report Behavioral Automaticity Index (SRBAI; Gardner et al., 2012) is a four-item subscale of the SRHI, developed to address conceptual concerns around the inclusion of behavioural frequency in the SRHI. Many studies have shown that the SRBAI predicts future behaviour (e.g. Gardner, 2015a; Gardner et al., 2012; Rebar et al., 2016). Where assessed alongside the SRHI, the SRBAI typically shows a weaker predictive effect on future behaviour (Gardner et al., 2012). This is likely due to the removal of behavioural frequency from the SRHI, which would be expected to inflate true automaticity–behaviour associations between automaticity and behaviour. The impact of habit on behaviour can be attributed to detection of habit cues and to automatic responding to these cues (Orbell & Verplanken, 2010). The SRBAI thus offers greater conceptual clarity than does the SRHI for research contexts in which the aim is to model the relationship between habit and behaviour by achieving a clearer distinction between habit and past behaviour than does the SRHI. However, excluding behavioural frequency also results in a conflation of habit and non-habit-related automaticity, as the repetition history that distinguishes habit from other forms of automaticity is not assessed.

While few studies have assessed the reliability of SRBAI scores over time, the measure has been used in several studies of habit formation (e.g. Gardner et al., 2014; Judah, Gardner, & Aunger, 2013; Kaushal & Rhodes, 2015; Matei et al., 2015). These studies have demonstrated that, in line with theoretical predictions regarding the habit formation process (Lally & Gardner, 2013; Lally et al., 2010), SRBAI scores gradually increase as people repeat behaviours in consistent settings.

Sniehotta and Presseau (2011) describe both the SRHI and the SRBAI as limited in that they reflect *symptoms* of habits, as opposed to direct assessment of the psychological process, although it should be noted that direct accounts of such processes would be extremely difficult to obtain (e.g. Nisbett & Wilson, 1977). Others have noted that these measures may not fully reflect habit in that they do not incorporate items that assess cues or the context-dependency that is integral to the theory of habit (Hargadon, 2017). However, despite these concerns, self-report measures are popular in the field. They have a good degree of validity, are reliable and—not unimportantly—are low-cost instruments that can be self-administered to large samples.

Future Directions for Habit Measurement

Habits are cognitive, motivational, and neurological processes (Wood & Rünger, 2016)—and in accordance with this perspective, the most promising future measures of habit are likely integrations of evidence from a range of disciplines. For example, habit measurement may be advanced through integration of neuroscience developments in deciphering brain dopamine signals as indications of behaviour being more reward-driven or cue-driven (Balleine & O'Doherty, 2010; Wise, 2004). Thematic analysis of vignettes, which are used as indications of implicit measures of achievement motivation, may prove adaptable as valid indirect measures of habit (Bernecker & Job, 2011; McClelland, Koestner, & Weinberger, 1989; Schultheiss & Pang, 2007; Woike & Bender, 2009). There are even potentially genetic identifiers that could be insightful for assessing habit (O'Hare et al., 2017). While it is still too early to foresee how such advancements may translate into valid habit measurement, multidisciplinary approaches seem promising.

One direction of emerging habit measurement research that is closer to the horizon is implicit measures. Most common to cognitive and social psychology, implicit measures are indirect assessments that do not require participants' subjective assessment (Gawronski & De Houwer, 2000). Because they are indirect, implicit measures are less vulnerable to response biases and less reliant on introspection than self-report measures (Greenwald et al., 2002; Nosek, Greenwald, & Banaji, 2007). Given that habitual behaviour is theorized as being driven by underlying cue–behaviour associations in procedural memory, in theory, implicit measures should be able to reflect the strength of people's automatic associations between cue and behaviour (Hagger, Rebar, Mullan, Lipp, & Chatzisarantis, 2015). This led Gardner (2015a) to recommend implicit measures as the gold-standard of habit measurement. However, it remains early days for the implicit measurement of habit. In a series of studies, Hargadon (2017) showed that an IAT adapted to assess hand-washing habit strength showed internal reliability and that the implicit measure of habit showed discriminant validity from conceptually distinctive implicit measures of attitudes and reflective attitudes toward hand-washing. Other implicit measures have been applied to habit research, not so much as measures of habit proper, but rather demonstrating the automaticity that is inherent to habit (e.g. Danner, Aarts, Papies, & de Vries, 2011; Hyde, 2013; Orbell & Verplanken, 2010). For example, Danner et al. (2011) used an implicit measure of cognitive accessibility and showed that people have attentional biases toward habitual behaviours more so than goal-directed behaviours. Orbell and Verplanken (2010) found SRHI scores correlating with attentional bias to smoking cues in a Stroop task.

An interesting category of implicit measures are those that are based on observing consequences of habits. An early observational measure was the Response-Frequency measure (e.g. Verplanken, Aarts, van Knippenberg, & van Knippenberg, 1994). In that paradigm participants are asked to make quick decisions between choice options. The prevalence of a prevalent response is then taken as a measure of habit. A problem with this measure is that, unless it is applied under strict time pressure conditions, it is easily confounding habit and attitude/intention. A more promising observation-type measurement is based on the phenomenon that habits may lead to action slips. This has been used to design a computerized outcome-devaluation task, the 'slips-of-action' paradigm (de Wit et al., 2012; see also Chap. 16, this volume). In this paradigm, habit is indicated by participants making choices for outcomes that have been devaluated during the procedure.

Although implicit habit measures are promising, questions remain unanswered. Implicit measures have psychometric limitations that need to be addressed before treating them as criteria for habit measurements. Validity of implicit measures is called into question more so than most self-report measures (Gawronski, LeBel, & Peters, 2007). On a practical note, it is not clear how best to visually represent the habit triggering cues. People can have different representations of their own habits (Gardner & Tang, 2014; Sniehotta & Presseau, 2011), and even for the same behaviour, people may have different habit triggering cues (e.g. Pimm et al., 2016). And on a more fundamental note, one may question whether implicit measures *should* be closely aligned with self-reported habit measurements. Self-reported and implicit measures can be expected to correlate to some extent, but they may tap into different aspects of habit, and thus show the typically low correlations found elsewhere between the two types of measures (Hofmann, Gawronski, Gschwendner, Le, & Schmitt, 2005).

Conclusions

A 'good' measure of habit will show sound construct validity through demonstrating predictive validity, discriminant validity, convergent validity, and reliability aligned with habit theory. Throughout this chapter, we have laid out a set of criteria for guiding habit measurement construct validity testing. Specifically, we propose that habit measures should (1) predict future behaviour (with instigation habit predicting frequency), (2) be distinct from other non-habit automatic and reflective constructs, (3) be positively associated with other indicators of habit and inversely associated with information processes of alternative behavioural response possibilities, and (4) be responsive to gradual change, while showing minimal assessment-to-assessment fluctuation in the absence of true change.

Based on the application of these validity criteria to prevalent measures of habit, we argue that past behaviour has predictive validity but does not show adequate discriminant validity, in that it does not only reflect habitual behaviour, and is therefore not a valid measure of habit. Similarly, frequency-in-context measures allow for more precision when measuring past behaviour and have been shown to predict future behaviour and be associated to relevant non-habit constructs, but do not reflect the automatic nature of habit and therefore are likely not valid reflections of only habitual behaviour. The SRHI and SRBAI have shown to predict future behaviour, be distinct from past behaviour, and are associated with relevant non-habit constructs. These measures are useful for administration to large samples and have aided advancement in understanding the nature of habitual behaviour; however, they are reliant on people's ability to accurately report the automaticity of their behaviour, which leads to questions regarding their convergent and discriminant validity. There are many promising directions for habit measurement including implicit measures such as the IAT, but such avenues of research are early and still lacking strong evidence of validity. All measures of habit have strengths and limitations, and therefore the appropriate measure of habit for any given study must be well suited and tethered to the research question, study logistics, and guiding theory.

Habit Research in Action: The Self-Report Habit Index

The Self-Report Habit Index (Verplanken & Orbell, 2003) is a generic self-report instrument to assess habit strength. It consists of a stem ('Behaviour X is something …'), followed by 12 items. The stem can refer to any behaviour. The researcher can choose to formulate this as general or specific as required, and may or may not include any context information (e.g. 'Conducting Behaviour X in Condition Y is something …'). The 12 items assess facets of habit, including lack of awareness and conscious intent, lack of control, mental efficiency and a sense of self-identity. The items are accompanied by Likert response scales (e.g. 5 or 7 point agree/disagree scales). The items may be slightly modified in order to accommodate a specific behaviour or context, and the researcher has to choose a time frame in item 7. After checking the internal reliability of the scale, the researcher typically averages the items into an overall habit strength assessment.

[Behavior X] is something…

1. I do frequently.
2. I do automatically.
3. I do without having to consciously remember.
4. That makes me feel weird if I do not do it.
5. I do without thinking.
6. That would require effort not to do it.
7. That belongs to my (daily, weekly, monthly) routine.
8. I start doing before I realize I'm doing it.
9. I would find hard not to do.
10. I have no need to think about doing.
11. that's typically 'me'.
12. I have been doing for a long time.

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References

Aarts, H., & Dijksterhuis, A. (2000). Habits as knowledge structures: Automaticity in goal-directed behavior. *Journal of Personality and Social Psychology, 78*(1), 53–63.

Aarts, H., Paulussen, T., & Schaalma, H. (1997). Physical exercise habit: On the conceptualization and formation of habitual health behaviours. *Health Education Research, 12*(3), 363–374.

Aarts, H., Verplanken, B., & Knippenberg, A. (1998). Predicting behavior from actions in the past: Repeated decision making or a matter of habit? *Journal of Applied Social Psychology, 28*(15), 1355–1374. https://doi.org/10.1111/j.1559-1816.1998.tb01681.x.

Adams, C. D. (1982). Variations in the sensitivity of instrumental responding to reinforcer devaluation. *Quarterly Journal of Experimental Psychology B: Comparative and Physiological Psychology, 34B*, 77–98.

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*(2), 107–122. https://doi.org/10.1207/S15327957PSPR0602_02.

Aldridge, V. K., Dovey, T. M., & Wade, A. (2017). Assessing test-retest reliability of psychological measures. *European Psychologist, 22*, 207–218. https://doi.org/10.1027/1016-9040/a000298.

Bagozzi, R. P. (1981). Attitudes, intentions, and behavior: A test of some key hypotheses. *Journal of Personality and Social Psychology, 41*(4), 607–627. https://doi.org/10.1037/0022-3514.41.4.607.

Bagozzi, R. P., & Yi, Y. (1989). The degree of intention formation as a moderator of the attitude-behavior relationship. *Social Psychology Quarterly, 52*(4), 266–279. https://doi.org/10.2307/2786991.

Balleine, B. W., & O'Doherty, J. P. (2010). Human and rodent homologies in action control: Corticostriatal determinants of goal-directed and habitual action. *Neuropsychopharmacology, 35*(1), 48–69.

Bernecker, K., & Job, V. (2011). Assessing implicit motives with an online version of the picture story exercise. *Motivation and Emotion, 35*(3), 251–266. https://doi.org/10.1007/s11031-010-9175-8.

Danner, U. N., Aarts, H., Papies, E. K., & de Vries, N. K. (2011). Paving the path for habit change: Cognitive shielding of intentions against habit intrusion. *British Journal of Health Psychology, 16*(1), 189–200. https://doi.org/10.1348/2044-8287.002005.

de Bruijn, G.-J. (2010). Understanding college students' fruit consumption. Integrating habit strength in the theory of planned behaviour. *Appetite, 54*(1), 16–22. https://doi.org/10.1016/j.appet.2009.08.007.

de Wit, S., Watson, P., Harsay, H. A., Cohen, M. X., van de Vijver, I., & Ridderinkhof, K. R. (2012). Corticostriatal connectivity underlies individual differences in the balance between habitual and goal-directed action control. *The Journal of Neuroscience, 32*(35), 12066–12075. https://doi.org/10.1523/JNEUROSCI.1088-12.2012.

Evans, J. S. B., & Frankish, K. E. (2009). *In two minds: Dual processes and beyond*. London: Oxford University Press.

Friedrichsmeier, T., Matthies, E., & Klöckner, C. A. (2013). Explaining stability in travel mode choice: An empirical comparison of two concepts of habit. *Transportation Research Part F: Traffic Psychology and Behaviour, 16*, 1–13.

Friese, M., Hofmann, W., & Wiers, R. W. (2011). On taming horses and strengthening riders: Recent developments in research on interventions to improve self-control in health behaviors. *Self and Identity, 10*(3), 336–351. https://doi.org/10.1080/15298868.2010.536417.

Gardner, B. (2012). Habit as automaticity, not frequency. *European Health Psychologist, 14*(2), 32–36.

Gardner, B. (2015a). A review and analysis of the use of 'habit'in understanding, predicting and influencing health-related behaviour. *Health Psychology Review, 9*(3), 277–295. https://doi.org/10.1080/17437199.2013.876238.

Gardner, B. (2015b). Defining and measuring the habit impulse: Response to commentaries. *Health Psychology Review, 9*(3), 318–322.

Gardner, B., Abraham, C., Lally, P., & de Bruijn, G.-J. (2012). Towards parsimony in habit measurement: Testing the convergent and predictive validity of an automaticity subscale of the self-report habit index. *International Journal of Behavioral Nutrition and Physical Activity, 9*(1), 102. https://doi.org/10.1186/1479-5868-9-102.

Gardner, B., Corbridge, S., & McGowan, L. (2015). Do habits always override intentions? Pitting unhealthy snacking habits against snack-avoidance intentions. *BMC Psychology, 3*(1), 8. https://doi.org/10.1186/s40359-015-0065-4.

Gardner, B., de Bruijn, G.-J., & Lally, P. (2011). A systematic review and meta-analysis of applications of the self-report habit index to nutrition and physical activity behaviours. *Annals of Behavioral Medicine, 42*(2), 174–187.

Gardner, B., Phillips, L. A., & Judah, G. (2016). Habitual instigation and habitual execution: Definition, measurement, and effects on behaviour frequency. *British Journal of Health Psychology, 21*(3), 613–630. https://doi.org/10.1111/bjhp.12189.

Gardner, B., Sheals, K., Wardle, J., & McGowan, L. (2014). Putting habit into practice, and practice into habit: A process evaluation and exploration of the acceptability of a habit-based dietary behaviour change intervention. *International Journal of Behavioral Nutrition and Physical Activity, 11*(1), 135–147.

Gardner, B., & Tang, V. (2014). Reflecting on non-reflective action: An exploratory think-aloud study of self-report habit measures. *British Journal of Health Psychology, 19*(2), 258–273.

Gawronski, B., & De Houwer, J. (2000). Implicit measures in social and personality psychology. In H. T. Reis & C. M. Judd (Eds.), *Handbook of research methods in social and personality psychology* (2nd ed., pp. 283–310). New York: Cambridge University Press.

Gawronski, B., LeBel, E. P., & Peters, K. R. (2007). What do implicit measures tell us?: Scrutinizing the validity of three common assumptions. *Perspectives on Psychological Science, 2*(2), 181–193. https://doi.org/10.1111/j.1745-6916.2007.00036.x.

Greenwald, A. G., Banaji, M. R., Rudman, L. A., Farnham, S. D., Nosek, B. A., & Mellott, D. S. (2002). A unified theory of implicit attitudes, stereotypes, self-esteem, and self-concept. *Psychological Review, 109*(1), 3–25. https://doi.org/10.1037/0033-295X.109.1.3.

Hagger, M. S., Rebar, A. L., Mullan, B., Lipp, O. V., & Chatzisarantis, N. L. D. (2015). The subjective experience of habit captured by self-report indexes may lead to inaccuracies in the measurement of habitual action. *Health Psychology Review, 9*(3), 296–302. https://doi.org/10.1080/17437199.2014.959728.

Hargadon, D. P. (2017). *Developing an implicit measure of habit strength: The habit IAT*. Kingston, ON: Queen's University.

Haynes, S. N., Richard, D., & Kubany, E. S. (1995). Content validity in psychological assessment: A functional approach to concepts and methods. *Psychological Assessment, 7*(3), 238–247.

Hofmann, W., Gawronski, B., Gschwendner, T., Le, H., & Schmitt, M. (2005). A meta-analysis on the correlation between the implicit association test and explicit self-report measures. *Personality and Social Psychology Bulletin, 31*(10), 1369–1385.

Hyde, A. L. (2013). Automatic regulation of physical activity (Doctoral dissertation). The Pennsylvania State University, University Park, PA, United States of America.

Jackson, R. C., & Baker, J. S. (2001). Routines, rituals, and rugby: Case study of a world class goal kicker. *The Sport Psychologist, 15*(1), 48–65.

Ji, M. F., & Wood, W. (2007). Purchase and consumption habits: Not necessarily what you intend. *Journal of Consumer Psychology, 17*(4), 261–276.

Judah, G., Gardner, B., & Aunger, R. (2013). Forming a flossing habit: An exploratory study of the psychological determinants of habit formation. *British Journal of Health Psychology, 18*(2), 338–353.

Kaushal, N., & Rhodes, R. E. (2015). Exercise habit formation in new gym members: A longitudinal study. *Journal of Behavioral Medicine, 38*(4), 652–663.

Kaushal, N., Rhodes, R. E., Meldrum, J. T., & Spence, J. C. (2017). The role of habit in different phases of exercise. *British Journal of Health Psychology, 22*(3), 429–448. https://doi.org/10.1111/bjhp.12237.

Kelly, M. T., Rennie, K. L., Wallace, J. M., Robson, P. J., Welch, R. W., Hannon-Fletcher, M. P., et al. (2009). Associations between the portion sizes of food groups consumed and measures of adiposity in the British National Diet and nutrition survey. *British Journal of Nutrition, 101*(9), 1413–1420. https://doi.org/10.1017/S0007114508060777.

Kline, P. (2013). *Handbook of psychological testing* (2nd ed.). London and New York: Routledge.

Kurz, T., Gardner, B., Verplanken, B., & Abraham, C. (2015). Habitual behaviors or patterns of practice? Explaining and changing repetitive climate-relevant actions. *Wiley Interdisciplinary Reviews: Climate Change, 6*(1), 113–128.

Lally, P., & Gardner, B. (2013). Promoting habit formation. *Health Psychology Review, 7*(sup1), S137–S158.

Lally, P., Van Jaarsveld, C. H., Potts, H. W., & Wardle, J. (2010). How are habits formed: Modelling habit formation in the real world. *European Journal of Social Psychology, 40*(6), 998–1009. https://doi.org/10.1002/ejsp.674.

Matei, R., Thuné-Boyle, I., Hamer, M., Iliffe, S., Fox, K. R., Jefferis, B. J., et al. (2015). Acceptability of a theory-based sedentary behaviour reduction intervention for older adults ('On Your Feet to Earn Your Seat'). *BMC Public Health, 15*(1), 606. https://doi.org/10.1186/s12889-015-1921-0.

McClelland, D. C., Koestner, R., & Weinberger, J. (1989). How do self-attributed and implicit motives differ? *Psychological Review, 96*(4), 690–702. https://doi.org/10.1037/0033-295X.96.4.690.

Messick, S. (1990). Validity of test interpretation and use. *ETS Research Report Series, 1990*(1), 1487–1495. https://doi.org/10.1002/j.2333-8504.1990.tb01343.x.

Nisbett, R. E., & Wilson, T. D. (1977). Telling more than we can know: Verbal reports on mental processes. *Psychological Review, 84(3)*, 231-259.

Nocon, M., Hiemann, T., Müller-Riemenschneider, F., Thalau, F., Roll, S., & Willich, S. N. (2008). Association of physical activity with all-cause and cardiovascular mortality: A systematic review and meta-analysis. *European Journal of Cardiovascular Prevention & Rehabilitation, 15*(3), 239–246.

Nosek, B. A., Greenwald, A. G., & Banaji, M. R. (2007). The implicit association test at age 7: A methodological and conceptual review. In J. A. Bargh (Ed.), *Social psychology and the unconscious: The automaticity of higher mental processes* (pp. 265–292). New York: Psychology Press.

O'Flaherty, M., Flores-Mateo, G., Nnoaham, K., Lloyd-Williams, F., & Capewell, S. (2012). Potential cardiovascular mortality reductions with stricter food policies in the United Kingdom of Great Britain and Northern Ireland. *Bulletin of the World Health Organization, 90*(7), 522–531.

O'Hare, J. K., Li, H., Kim, N., Gaidis, E., Ade, K., Beck, J., et al. (2017). Striatal fast-spiking interneurons selectively modulate circuit output and are required for habitual behavior. *eLife, 6*, e26231. https://doi.org/10.7554/eLife.26231.

Orbell, S., & Verplanken, B. (2010). The automatic component of habit in health behavior: Habit as cue-contingent automaticity. *Health Psychology, 29*(4), 374–383.

Orbell, S., & Verplanken, B. (2015). The strength of habit. *Health Psychology Review, 9*(3), 311–317. https://doi.org/10.1080/17437199.2014.992031.

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*(1), 54–74.

Phillips, L. A., & Gardner, B. (2016). Habitual exercise instigation (vs. execution) predicts healthy adults' exercise frequency. *Health Psychology, 35*(1), 69–77. https://doi.org/10.1037/hea0000249.

Pimm, R., Vandelanotte, C., Rhodes, R. E., Short, C., Duncan, M. J., & Rebar, A. L. (2016). Cue consistency associated with physical activity automaticity and behavior. *Behavioral Medicine, 42*(4), 248–253.

Pratt, M., Macera, C. A., & Wang, G. (2000). Higher direct medical costs associated with physical inactivity. *The Physician and Sports Medicine, 28*(10), 63–70.

Quinn, J. M., Pascoe, A., Wood, W., & Neal, D. T. (2010). Can't control yourself? Monitor those bad habits. *Personality and Social Psychology Bulletin, 36*(4), 499–511.

Rebar, A. L. (2017). Automatic regulation used in sport and exercise research. In O. Braddick (Ed.), *Oxford research encyclopedia of psychology*. New York: Oxford University Press.

Rebar, A. L., Dimmock, J. A., Jackson, B., Rhodes, R. E., Kates, A., Starling, J., et al. (2016). A systematic review of the effects of non-conscious regulatory processes in physical activity. *Health Psychology Review, 10*(4), 395–407. https://doi.org/10.1080/17437199.2016.1183505.

Rebar, A. L., Gardner, B., & Verplanken, B. (2018). Habit in exercise behavior. In G. Tenenbaum & R. C. Eklund (Eds.), *Handbook of sport psychology* (Vol. 4). Hoboken, NJ: Wiley.

Rhodes, R. E., & Courneya, K. S. (2003). Modelling the theory of planned behaviour and past behaviour. *Psychology, Health & Medicine, 8*(1), 57–69.

Rhodes, R. E., & de Bruijn, G.-J. (2013). How big is the physical activity intention–behaviour gap? A meta-analysis using the action control framework. *British Journal of Health Psychology, 18*(2), 296–309.

Rhodes, R. E., de Bruijn, G.-J., & Matheson, D. H. (2010). Habit in the physical activity domain: Integration with intention temporal stability and action control. *Journal of Sport and Exercise Psychology, 32*(1), 84–98. https://doi.org/10.1123/jsep.32.1.84.

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

Schultheiss, O. C., & Pang, J. S. (2007). Measuring implicit motives. In R. W. Robins, R. C. Fraley, & R. F. Krueger (Eds.), *Handbook of research methods in personality psychology* (pp. 322–344). New York: Guilford Press.

Sniehotta, F. F., & Presseau, J. (2011). The habitual use of the self-report habit index. *Annals of Behavioral Medicine, 43*(1), 139–140. https://doi.org/10.1007/s12160-011-9305-x.

Strack, F., & Deutsch, R. (2004). Reflective and impulsive determinants of social behavior. *Personality and Social Psychology Review, 8*(3), 220–247. https://doi.org/10.1207/s15327957pspr0803_1.

Thompson, R. L., Higgins, C. A., & Howell, J. M. (1991). Personal computing: Toward a conceptual model of utilization. *Management Information Systems Quarterly, 15*(1), 125–143.

Triandis, H. C. (1980). Values, attitudes, and interpersonal behavior. In *Nebraska Symposium on Motivation* (Vol. 27, pp. 195–259). Lincoln, NE: University of Nebraska Press.

Verhoeven, A. A., Kindt, M., Zomer, C. L., & de Wit, S. (2018). An experimental investigation of breaking learnt habits with verbal implementation intentions. *Acta Psychologica, 184*, 124–136.

Verplanken, B. (2006). Beyond frequency: Habit as mental construct. *British Journal of Social Psychology, 45*(3), 639–656. https://doi.org/10.1348/014466605X49122.

Verplanken, B. (2010). Habit: From overt action to mental events. In C. R. Agnew, D. E. Carlston, W. G. Graziano, & J. R. Kelly (Eds.), *Then a miracle occurs: Focusing on behavior in social psychological theory and research* (pp. 68–88). Oxford: Oxford University Press.

Verplanken, B., & Aarts, H. (1999). Habit, attitude, and planned behaviour: Is habit an empty construct or an interesting case of goal-directed automaticity? *European Review of Social Psychology, 10*(1), 101–134. https://doi.org/10.1080/14792779943000035.

Verplanken, B., Aarts, H., & Van Knippenberg, A. (1997). Habit, information acquisition, and the process of making travel mode choices. *European Journal of Social Psychology, 27*(5), 539–560.

Verplanken, B., Aarts, H., van Knippenberg, A., & van Knippenberg, C. (1994). Attitude versus general habit: Antecedents of travel mode choice. *Journal of Applied Social Psychology, 24*, 285–300.

Verplanken, B., Aars, H., Knippenberg, A., & Moonen, A. (1998). Habit versus planned behaviour: A field experiment. *British Journal of Social Psychology, 37(1)*, 111-128.

Verplanken, B., & Faes, S. (1999). Good intentions, bad habits, and effects of forming implementation intentions on healthy eating. *European Journal of Social Psychology, 29*(56), 591–604.

Verplanken, B., & Fisher, N. (2014). Habitual worrying and benefits of mindfulness. *Mindfulness, 5*(5), 566–573. https://doi.org/10.1007/s12671-013-0211-0.

Verplanken, B., Friborg, O., Wang, C. E., Trafimow, D., & Woolf, K. (2007). Mental habits: Metacognitive reflection on negative self-thinking. *Journal of Personality and Social Psychology, 92*(3), 526–541. https://doi.org/10.1037/002.3514.92.3.526.

Verplanken, B., & Melkevik, O. (2008). Predicting habit: The case of physical exercise. *Psychology of Sport and Exercise, 9*(1), 15–26. https://doi.org/10.1016/j.psychsport.2007.01.002.

Verplanken, B., Myrbakk, V., & Rudi, E. (2005). The measurement of habit. In T. Betsch & S. Haberstroh (Eds.), *The routines of decision making* (Vol. 231–247, p. 247). New York and Hove: Psychology Press.

Verplanken, B., & Orbell, S. (2003). Reflections on past behavior: A self-report index of habit strength. *Journal of Applied Social Psychology, 33*(6), 1313–1330. https://doi.org/10.1111/j.1559-1816.2003.tb01951.x.

Verplanken, B., & Roy, D. (2016). Empowering interventions to promote sustainable lifestyles: Testing the habit discontinuity hypothesis in a field experiment. *Journal of Environmental Psychology, 45*, 127–134.

Verplanken, B. & Sui, J. (2018). *Habit and identity: Behavioural, cognitive, affective, and motivational facets of an integrated self*. Unpublished data.

Verplanken, B., & Tangelder, Y. (2011). No body is perfect: The significance of habitual negative thinking about appearance for body dissatisfaction, eating disorder propensity, self-esteem and snacking. *Psychology & Health, 26*(6), 685–701. https://doi.org/10.1080/08870441003763246.

Verplanken, B., Walker, I., Davis, A., & Jurasek, M. (2008). Context change and travel mode choice: Combining the habit discontinuity and self-activation hypotheses. *Journal of Environmental Psychology, 28*(2), 121–127.

Walker, I., Thomas, G. O., & Verplanken, B. (2015). Old habits die hard: Travel habit formation and decay during an office relocation. *Environment and Behavior, 47*(10), 1089–1106.

Watkins, E. R. (2008). Constructive and unconstructive repetitive thought. *Psychological Bulletin, 134*(2), 163–206.

Wise, R. A. (2004). Dopamine, learning and motivation. *Nature Reviews Neuroscience, 5*(6), 483–494.

Woike, B. A., & Bender, M. (2009). Implicit motives as a way to understand cognitive processes. *Social and Personality Psychology Compass, 3*(5), 702–710.

Wood, W., & Neal, D. T. (2007). A new look at habits and the habit-goal interface. *Psychological Review, 114*(4), 843–863. https://doi.org/10.1037/0033-295X.114.4.843.

Wood, W., & Neal, D. T. (2016). Healthy through habit: Interventions for initiating & maintaining health behavior change. *Behavioral Science & Policy, 2*(1), 71–83.

Wood, W., Quinn, J. M., & Kashy, D. A. (2002). Habits in everyday life: Thought, emotion, and action. *Journal of Personality and Social Psychology, 83*(6), 1281–1297.

Wood, W., & Rünger, D. (2016). Psychology of habit. *Annual Review of Psychology, 67*, 289–314.

Wood, W., Tam, L., & Witt, M. G. (2005). Changing circumstances, disrupting habits. *Journal of Personality and Social Psychology, 88*(6), 918–933.

Chapter 4
Understanding the Formation of Human Habits: An Analysis of Mechanisms of Habitual Behaviour

Hans Marien, Ruud Custers, and Henk Aarts

Human behaviour is sensitive to learning, influenced by past experiences, and tends to be organized and structured in the service of future action. On an individual level, such learning readily supports physical and social needs that have to be satisfied for healthy functioning and well-being, such as finding food, water, shelter, and mating partners. Learning plays an important role in social interaction in simple and more complex social contexts. In this case, learning from the past shapes human behaviour in social structures, and creates rituals, customs, and norms that constitute institutions and culture.

It is hard to ignore the pivotal role of learning in human conduct, but what might be even more fundamental is the question of what learning actually installs. One answer to this question comes from the notion that our history of learning creates behavioural patterns that can be executed and repeated easily and swiftly. It turns out that a major part of our behavioural repertoire is frequently and consistently executed in the same physical and social environment and has taken on a stable character. Such stability of action speaks to the notion that humans, like other animals, are creatures of habit, allowing them to select and perform behaviour skillfully and without much consideration, leaving room for other important challenges and opportunities that need conscious deliberation.

Whereas this functional view on habits shows clear benefits as a result of extensive practice, habits also have a downside. A consequence of repeatedly executing actions in the same context is that behaviour becomes automatized, and hence difficult to control. This dysfunctional aspect of habits has been taken as illustration that people have always done things against their better judgment, and indeed, Plato and Socrates already wrote about this reality (Plato, 380 BC/1986, see also Davidson, 1980). Socrates called the experience of acting against one's will *akrasia,* which can

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roughly be translated as 'weakness of will'. This apparent weakness of the will makes the study on human habitual behaviour important and intriguing.

Research on habits in psychology has devoted much theoretical and empirical attention to the functional and dysfunctional aspects of habits (Aarts & Custers, 2009). What can be considered as one of the first studies on habits, Ach (1910) developed the so-called combined method experiments in which habit and the will operated in opposition. Ach considered habits as highly automated and even reflexive processes that do not need the will to be performed. Rather, habits follow a ballistic route to completion and, as such, are uncontrollable unless an inner force could take a hold of them. This inner force pertaining to the will has also been labeled in other ways, such as volition, self-determination, and commitment, and forms the core aspect of modern views on the role of consciousness in self-control and the regulation of behaviour.

Irrespective of the exact labels, findings of many studies suggest that the human ability to counteract habits is not well developed. In social interaction, for example, this inability might take undesirable forms when one habitually offends another person while having the intention to say something nice. Habits also easily intrude and produce errors and action slips that go against the will (Heckhausen & Beckmann, 1990; Reason, 1979). A typical instance of action slips as a result of well-established habits and skills pertains to the situation in which one mindlessly engages in a daily routine, e.g. going to the bath room to take a morning shower, and one's actions start to divert because another routine becomes active in the context at hand, e.g. putting on make-up (de Graaf, 2012). The habit versus the will paradigm thus allows researchers to examine the mechanisms of human habits by studying how extensive practice produces habitual behaviour that materializes without the will or, conversely, goes against our will. Accordingly, research on habits addresses functional aspects of automaticity in human behaviour.

Features of Automaticity in Habitual Behaviour

The study on automaticity in human behaviour has a long tradition in psychological science. Several research programs have looked into specific functional components that represent automatic processes in learning and performance. Automaticity has been illustrated in sensorimotor processes, perception, memory, evaluation, judgment and the selection and execution of behaviour. Whereas this research has addressed different aspects and levels of human functioning, there is general agreement that automatic processes can be characterized by a few basic qualities (Bargh, 1994). More particularly, the literature distinguishes four different features of automaticity that accompany the formation of habits: Efficiency, non-intentionality, unawareness, and uncontrollability. Below we discuss these four features of automaticity in habitual behaviour in more detail.

Habits Are Efficient

The first feature of automatic habitual mechanisms is that they are efficient. To examine this feature researchers use dual task settings in which participants have to perform a skill while simultaneously performing another task that requires mental effort (e.g. Brown & Carr, 1989). Such habitual skill might be trained in the dual task itself or it might a pre-existing one. For instance, participants can be asked to practice a speeded key press task for 4 h while also engaging in a digit-span task (i.e. remembering a series of 8 digits and then recalling them after having performed a sequence of key presses). The idea behind such a dual task setting is that the execution of one of the tasks interferes with performance on the other task in terms of speed and/or accuracy. Interference in these tasks may result from a single-channel constraint that forces processes to run sequentially or interference may result from capacity limitations so that a finite pool of resources needs to be shared by different tasks (Pashler, Johnston, & Ruthruff, 2001). Interference produces performance impairment (in speed and/or accuracy) on one of the two tasks when concurrent processes (e.g. sustained attention to task-relevant information) have to be used for performing both tasks or when processing resources are allocated to one task leaving fewer resources for the other task.

Generally speaking, the finding is that when one task has become habitual (e.g. relatively late in a 4-h practice session), participants can perform the other task simultaneously with little interference; but that there is considerable interference between the additional task and the skill learning task when the learning task is novel or not overlearned (e.g. relatively early in a 4-h practice session). Assuming that the amount of interference in a dual task setting represents a measure of efficiency, the findings that performance of a well-learned set of behavioural responses and schemas does not affect the performance of the other task suggest that habits allow people to act in their environment without recruiting attentional resources and effort.

Habits Are Independent of Intention

The second feature of automaticity in habitual mechanisms pertains to the notion that habits can occur independent of intention, that is, a consciously expressed or formulated plan to perform a specific action in the near future. Accordingly, several streams of research have been explored and tested whether habits operate independently of intentions (Aarts, Verplanken, & van Knippenberg, 1998). One type of research that seems especially relevant for the present volume concerns studies dealing with the prediction of behaviour. The main question addressed in this research concerns the extent to which human behaviour is under intentional or habitual control (Verplanken, Aarts, van Knippenberg, & van Knippenberg, 1994). A variety of different behaviours have been investigated that share the characteristic of being repetitive in nature, such as students' class attendance, purchasing fast food, physical exercise, condom use, drug use, seat belt use, watching TV, commuting by car, and recycling. In a typical study, people are asked to explicitly express their intentions to engage in a specified behaviour and the strength of existing habits (reflected in frequency and/or stability of past performance in a given context) and future performance is assessed. Structural equation modelling is used to predict future performance from peoples intentions and their habits (Danner, Aarts, & de Vries, 2008). The standard result is that frequency of past behaviour rather than intentions predict people's activities.

Whereas the direct relationship between frequency of past behaviour and future behaviour only tells us that we do the things as we did them in the past, an interesting follow-up analysis in some of these studies revealed that habit and intention interact in their prediction of later behaviour. As the same behaviour is more frequently executed in the past and increases in habit strength, it is less guided by intentions to perform that behaviour. To illustrate this notion, in a study on travel mode behaviour, inhabitants of a village nearby a larger city filled out a survey that required them to indicate their intentions and frequency of using the car to commute to the city (Verplanken, Aarts, van Knippenberg, & Moonen, 1998). Next, the respondents' travel behaviour was monitored for a couple of weeks so that their car use could be predicted by their intentions and frequency of past car use. Results demonstrated that this measure of previous behaviour indeed interacted with intentions in the prediction of future travel behaviour: when the habit was strong intentions did not predict car-commuting behaviour, whereas the behaviour was predicted by intentions when the habit was weak. The interactive contribution of habit and intention in the prediction of behaviour is also evident for other types of human activity, such as buying alcoholic beverages when going out, ordering fast-food in restaurants, and especially shows up when the behaviour is repeatedly and consistently performed in the same context (see for a meta-analysis: Ouellette & Wood, 1998).

Habits Are Independent of Awareness

The third feature of automaticity of habits is that they are independent of conscious awareness. Most researchers agree that some parts of habitual mechanisms operate outside of awareness, and that habits or skills are partly represented in nondeclarative (or procedural) memory (Squire, Knowlton, & Musen, 1993). Nondeclarative literally means that it is difficult to mentally access these cognitive systems. For instance, it may be impossible to report on how one controls the muscles of one's hand and fingers when using a pencil to draw a picture. Similarly, one may not be able to verbally report on all the muscle movements in arms and legs while driving the car to work. This suggests that people can acquire and perform habitual skills in the absence of conscious awareness.

An extensive literature on implicit skill learning, for instance, shows that, people acquire and make use of associations between stimuli and responses and even rules of responding to complex sequences of stimuli during performance without awareness of these mechanisms (Cleeremans, Destrebecqz, & Boyer, 1998). In the serial reaction time task, participants press a key when a stimulus appears on the screen. The stimulus can appear in one of four locations, corresponding to four response keys. Participants are not informed that some of the stimuli appear in a repeated sequence. In general, participants seem to have apprehended the sequence of the spatial locations (i.e. get better at the task with practice for stimuli that appear in a repeated sequence) even when they are not able to verbally report the sequential order of the locations.

Implicit learning research suggests that people can acquire knowledge relevant to establish skills in the absence of conscious awareness. It is important to note that conscious awareness is often operationalized as the degree to which one can introspect one's inner mental life and subjectively report on it. Evidence of awareness of action is taken when one reports to be aware of the control or adjustment of the execution of behaviour, and this awareness measure is associated with the behaviour. However, there is evidence suggesting that adjustments of which we can become aware of remain unconscious, hence questioning whether our conscious experiences tell us the true story about how we regulate parts of our skills and habits (Fourneret & Jeannerod, 1998). In a study on hand movement, participants had to draw a straight line on a computer screen (a well-practiced skill that most people already learn early in their life has habitual characteristics). Participants could not see their hand or arm, and received false visual feedback via a mirror presentation of the computer screen about the trajectory of their hand movement. Thus, participants had to make considerable deviations to draw a straight line. Whereas participants displaced their hand in the opposite direction for producing a straight line, verbal reports showed that participants were unaware of making deviant manual movements in response to the false feedback—in fact, they claimed to have made straight movements. These findings indicate that people adjust their skilled actions or habits in response to deviations but that this type of action control underlying action can occur without conscious awareness.

Habits Are Uncontrollable

This last feature is the uncontrollability of automatic habitual mechanisms. This is most prominently shown by research investigating action slips (Heckhausen & Beckmann, 1990; Reason, 1979; see also Chap. 16). Action slips can occur, for instance, when a particular habitual action is enacted upon immediately even though it is usually executed in another context. A classic example is that of a person who usually buys a magazine at a local newsstand on his way to the office, but suddenly finds himself standing in front of that newsstand at the moment the person is shopping with his wife. So, even though it was the person's intention to visit several shops and stores, this person was not able to control the habitual act to buy the magazine, because the habit was automatically triggered in the context at hand despite the intention to act otherwise.

Uncontrollability of habitual mechanisms also suggests that they are independent of executive control processes. This has been nicely demonstrated by neuroimaging studies. Several studies have explored the changes in brain activity after an action has been sufficiently practiced and has become habitual (e.g. Kelly & Garavan, 2005). It has been found that brain activation is decreased after practice in areas that are involved with control processes (e.g. processes that monitor the successful execution of action). These control processes are mainly taken care of by areas in the prefrontal cortex (PFC), anterior cingulate cortex (ACC), and posterior parietal cortex (PPC) of the brain. In other words, these areas are mainly recruited when a person is performing unskilled and nonhabitual actions but over time when these actions are performed frequently in stable contexts, instigation and execution of these actions become more independent of these control networks, thus making them less controllable.

The Evolvement of Habitual Mechanisms

The four features of automaticity addressed above are suggested to have their own time-course of change with practice in the formation and establishment of habits (e.g. some habits may evolve faster from conscious to non-conscious cognitive processes than from non-efficient to efficient skill performance of the perceptual-motor components of a task). As such, the features play different roles in different aspects that have been demonstrated to be relevant to action performance: The preparation, selection and execution of behaviour (Aarts & Custers, 2009).

Importantly, habitual behaviour is sometimes characterized as being fully automatic: The preparation, selection, and execution of behaviour is efficient, independent of intentions, occurs outside of conscious awareness, and uncontrollable. Some researchers believe that a considerable part of our behavioural repertoire meets this full automaticity criterion. Whereas this might be the case for very simple stimulus–response links that are more or less under command of a reflexive system, it might be questioned whether habits are always fully automatic (see also Chap. 21). The concept of habit refers to stable patterns of behaviour that evolve from biological and social processes and may be simple but also more complex to execute. Accordingly, a particular way to understand and examine the mechanisms of habitual behaviour is to examine the full spectrum, and systematically move from fully automatic habits to automatic habitual skills that are dependent on the presence of an active goal. Such an analysis might reveal how evolution stamped in biologically driven functional behaviour in animals, and that primates, and especially humans, have evolved to become more advanced adaptive species in developing habits to deal with the changes in the complex social world they live in (Maturana & Varela, 1987). Interestingly, and in hindsight, the history of the study on habits seems to have followed a similar path, in the sense of treating human behaviour from a fully automatic animal model perspective to a full in-control human learning view.

Fully Automatic S-R Behaviour

The conceptualization of habits as fully automatic has been most prominent in behaviourist approaches to learning of behaviour (Skinner, 1953; Watson, 1925). According to behaviourist S–R theories, in essence all learning involves forming associations between stimuli and responses, and such links can be established and reinforced by positive outcomes that follow responses to a stimulus. If a person, for instance, opens the fridge after entering the kitchen and sequentially enjoys a refreshing beverage, the response of opening the fridge becomes more likely to occur when entering the kitchen. In other words, if positive outcomes consistently follow a particular response to a particular stimulus an S–R link develops that can be considered a basic habit. As a result, exposure to the stimulus directly and automatically 'hijacks' the preparation, selection and execution of the associated response, thus rendering human action efficient, intention-independent, nonconscious and uncontrollable. It is clear that a large part of our behaviour relies on such S-R links, and from a classic behaviourist perspective, not only animal behaviour, but also human behaviour can be regarded as being fully and automatically controlled by stimuli in the environment. Thus, if one would merely define habits as the occurrence of S-R instances, then we can conclude that the environment organizes and determines human behaviour and the story of habits would end here.

However, the S-R association principle only fares well when behaviour occurs under similar, if not identical, circumstances. Whereas the effects of small differences in circumstances for the learning and execution of S-R links have been largely explained away by a process of stimulus generalization (Rescorla, 1976) and response chaining (Adams, 1971), most people would agree that human behaviour can be repeated frequently and consistently in more complex environments, and that such habits cannot be easily understood and examined by means of simple S-R learning. This raises the question of whether fully automatic S-R mechanisms suffice to address the mechanisms by which habits are formed to deal with the dynamic world people live in.

Habitual Skills

Whereas considering habits as single responses to stimuli may work well for basic actions such as opening the fridge when entering the kitchen, other actions that are frequently and consistently executed in daily life—such as making coffee or driving to work—are a bit more complicated. Nevertheless, after some practice, these habitual skills can be executed in an automatic manner in such a way that they at least meet two of the above-described features of automaticity. By definition habitual skills are very efficient. Furthermore, lower level motor components of skillful behaviour are executed outside of conscious awareness. For instance, the habitual skill of making coffee may be triggered at the moment someone has finished her dinner. The skill of making coffee is further executed by setting off a chain-reaction in which each response triggers the next. Taking coffee beans out of the cupboard triggers the action of grinding the coffee beans, which in its turn triggers the action of filling the water reservoir. The execution of such response chains is highly efficient and has a ballistic character, which might also make them difficult to control once they are activated and run off to completion (Anderson et al., 2004). Moreover, people will not be able to verbally report which muscles to contract for each consecutive action.

The ballistic character of the execution of such response chains is possible because the instigation of a sequential action only relies on the previous response and does not depend on the actual behavioural outcome of the previous action. This open-loop mechanism does not use information about its outcomes as input (Wegner & Bargh, 1998). This may be the only way to execute complex behavioural patterns when there is no time to process feedback information about attaining outcomes (e.g. when playing a fast sequence of notes on a bass guitar). However, this mechanism might only work when the exact same sequence of responses is required. Any small change in the environment or execution of previous actions will lead the mechanism astray and cause the chain to break. In other words, in order to monitor progress of the action chain some form of control process might be needed to perform a habitual skill adequately.

Goal Dependency of Habits

The notion that habitual skills require a control process to run smoothly suggests that the execution of well-practiced and automatized skills is somewhat effortful and requires a goal to be active. Indeed, researchers have proposed that complex actions rely on internal models in which top-down and bottom-up processes interact in producing and guiding behaviour. These models are proposed to replace the rigid nature of S-R learning, and consider habits as semi-automatic actions that rely on closed-loop mechanisms that use information about its outcomes as input (e.g. Norman & Shallice, 1986; Powers, 1973). Building on theories of cybernetics (Wiener, 1948) a leading model in the cognitive science of habitual skill control is the TOTE model (Miller, Galanter, & Pribram, 1960) and, on a more fine-grained level, the forward model of sensorimotor control (Frith, Blakemore, & Wolpert, 2000). What these internal models have in common is the assumption that perceived outcomes are compared to their anticipated consequences and subsequent actions can be selected and tuned to produce the desired outcome. When driving a car to work for example, the required actions are largely the same (starting the car, pressing the gas pedal down, turn right at the coffee shop, etc.), but slightly different on subsequent occasions (the traffic light is red instead of green, or the wiper needs to be turned on because of the rain). Because of closed-loop mechanisms that use perceptual feedback as input for the selection and fine-tuning of responses, people are able to obtain the same outcomes, or goals, under different circumstances.

It is important to note that the role of goals can take two forms. First, habitual skills might be executed as a residual effect of another goal. For instance, a person might have the goal to study in the library, which might trigger the skill of talking silently and interact with others in a whisper mode (Aarts & Dijksterhuis, 2003). Thus, these skills do not directly serve the attainment of the goal, but their execution is nevertheless dependent on the presence of the goal. Most, if not all, measures of automatic processes in human habits require specific tasks or processing goals to direct subjects to the materials, procedure and response options, and hence, the manifestation of habitual behaviour depends on the presence of the goal at hand. Secondly, goals also play an essential role in performing habitual skills from an instrumentality perspective. Specifically, goals can trigger means that have been repeatedly selected in the past up to the point that they have become a habit (Aarts & Dijksterhuis, 2000). Once activated, these means run to completion and are controlled by an internal model that monitors progress and keeps the eye on the ball till the represented outcome of the goal has been obtained.

The involvement of goals does not necessarily mean that they are consciously accessible all the time. When learning to drive a car, for instance, conscious attention to driving may be required at first, but the involvement of conscious awareness of the goal to drive may drop out of the equation when this skill becomes overlearned. However, habitual skills still rely on a closed-loop mechanism in which internal models keep track on the attainment of the represented outcomes of actions. This raises the question of how outcome representations control skilled habitual behaviour for which execution seems somewhat effortful and, at the same time, occurs without much conscious thought.

The Role of Motivation in Habitual Behaviour

In order to answer that question it is important to take into account the role of motivation in habitual behaviour. One important aspect of learning and habit formation that we have overlooked so far is the power of rewards. Treating habitual behaviour as being motivated by rewards has, as we will see, important consequences for our understanding of the unfolding of habitual mechanisms into more complex behaviour. In the remaining part of this chapter, we take the liberty to revisit the evolution of habitual mechanisms, but instead of taking a completely cognitive perspective we will now examine the role of motivation in habits to gain a better understanding of how habitual behaviour can evolve from fully automatic processes to a more controlled modus operandi that rely on outcome representations.

The Role of Motivation in S–R Behaviour

As a first step to understand the role of motivation in habits, it is important to note that rewards or positive outcomes play a crucial role in reinforcing S–R links. These positive outcomes may arise from different sources, such as when other people administer them in operant conditioning (e.g. giving a compliment or a blatant amount of money). Using operant conditioning, the frequency of performing a response in a specific context can be increased by rewarding it with positive outcomes (Watson, 1925). Positive outcomes may also be used in classical or Pavlovian conditioning techniques (Rescorla & Wagner, 1972). Through these techniques, more complex relations can be learned between non-rewarding and rewarding stimuli. As a result, a dog—for instance—may be trained to sit at a particular command by rewarding the desired response with food. All these conditioning techniques reflect some of the basic learning mechanisms that are responsible for the formation of S–R habits, and it clearly demonstrates an important role for positive outcomes.

However, the positive outcomes that drive the learning and strengthening of S-R links are assumed to mainly result from basic biological and social needs. Because of these needs, certain objects or behaviours that have been learned to relieve certain deprivations may acquire incentive value (i.e. become associated with positive outcomes) and motivate actions that consequentially may satisfy the need. Drinking a glass of water, for instance, may prove rewarding when one is thirsty and hence the sight of such a glass may evoke the action.

This process of incentive learning and motivation has been extensively studied in animal and human research on the role of primary needs in reinforcement and reward learning. The general observation in this literature is that the motivational strength of a behavioural response increases if the response is followed by a positive event or reward (Thorndike, 1933). Whereas early research proposed that a positive event or reward that follows a response to a stimulus only increases the strength of the association between a stimulus and a response, there is now ample evidence suggesting that the reward itself becomes an integral part of the knowledge structure that allows individuals to anticipate the occurrence of the reward and to control subsequent instrumental actions to obtain it (Rescorla, 1990). This structure is represented in terms of a contingent relation between a response (R) and an outcome (O), such that performance of an instrumental action (e.g. pressing a button) can be influenced by the current value of the outcome (e.g. receiving food).

The Role of Motivation in Habitual Skills

Whereas the fundamental effects of rewards in shaping fully automatic habits have been first discovered in S-R learning, the role of positive outcomes in automatic behaviour has also been investigated in the domain of skill learning. Initially, research on practice and habitual skills was mainly interested in studying automaticity as a function of the binding between perceptual, cognitive and motor features as part of a task explicitly provided to participants. Accordingly, motivation and rewards were actually not part of the cognitive research agenda of habitual skill learning; an agenda that did not have room for terms like rewards and motivation that was strongly associated with the behaviouristic view on the role of reward and reinforcement learning in human behaviour. However, several lines of study started to challenge the idea that learning and performance of skills are not sensitive to rewards. First, skills are more rapidly learned under conditions of reward attainment, indicating that rewards may facilitate habitual skill performance indirectly—that is, after they are attained and motivate future choices and actions (e.g. O'Doherty, 2004).

Furthermore, performance of habitual skills increases in speed and accuracy when rewards are at stake. In a recent line of research we demonstrated how monetary rewards promote performance in several tasks that are highly practiced up to the level of a habitual skill, such as perceptual-motor task and working memory task pertaining to attention, storage and retrieval of items (see for a review, Zedelius et al., 2014). For instance, in one study (Zedelius, Veling, & Aarts, 2011) participants could earn money (1 cent or 50 cents) by accurately reporting a set of words after a delay. The rewards were presented as coins on the computer screen just before a trial. Results showed that performance on the maintenance task was higher for 50 cents trials than for 1 cent trials, showing a clear advantage in habitual skill performance when money can be earned. Another study showed that presentation of high (vs. low) monetary rewards increases the dilation of the pupil during the task performance, indicating that the performance of the habitual skill required some level of mental effort and control participants invested more mental effort (Bijleveld, Custers, & Aarts, 2009). An additional asset of these studies concerns the observation that the reward increasing effects on habitual skill execution even materialize when the reward cues are processed in a very brief time window, suggesting a close connection between motivation and cognition in the performance of habitual skills.

In short, then, the research alluded to above shows that, in an explicit task or goal setting context, perception of a reward cue influences processes that play a direct role in habitual skill performance and the attainment of the reward that is at stake.

The Role of Motivation in Goal–Directed Habitual Skills

It is interesting to note that most studies on habitual skills rely on explicit task instructions and goals are treated as a given. Hence, motivation for goals can be simply increased by rewarding the instructed task to learn or perform a habitual skill. However, many situations in daily life remain fairly ambiguous in terms of what a person should do, so that people often rely on internal outcome representations and self-inducement of goal-directed behaviour. Although outcome representations support the control of goal-directed action, they do not necessarily motivate behaviour. When an outcome representation does not carry sufficient reward value, spending mental effort to attain it would be a waste of energy. Fortunately, people have the ability to assess the value of outcomes (Dolan, 2002). Research suggests that such goal-value is enhanced when positive signals accompany the mere activation of outcome representations (Custers & Aarts, 2010). This affective-motivational process, in which an outcome becomes attached to a positive tag to then serve as an incentive, supports goal-directed behaviour in mobilizing effort.

In one study (Custers & Aarts, 2005), participants worked on a computer task, allegedly to test their computer-mouse skills. Before starting this test, some participants were exposed to words related to socializing (an outcome that can follow from performing specific actions, such as phoning a friend to meet at a bar). Others were exposed to words unrelated to this outcome. At the onset of the mouse-skill test, they were told that if there would be enough time left after this task, they could engage in a lottery in which they could win tickets to a popular party. Thus, working faster on the mouse-skill test was instrumental in attaining the goal to socialize. The participants indeed worked harder (i.e. expended more effort) on the mouse-skill test when the outcome of socializing was activated, and this effect was stronger when socializing evoked a stronger positive affective response (which was assessed in a separate implicit affective association task or manipulated by a conditioning task). This concurs with the view that the value a person assigns to outcome representations as a result of positive affective experiences with the outcome is a key to the motivational control over goal-directed behaviour (Berridge, 2001; Dickinson & Balleine, 1995).

Most studies on the combined role of outcome representations and reward information in motivating goal-directed behaviour assume that the given behavioural information (concepts such as socializing, physical exertion, etc.) is indeed represented by participants as an outcome of their actions (e.g. Marien, Aarts, & Custers, 2013). However, recent treatments of the ideomotor theory (a theory that can explain how outcome representations cause people to start up actions), clearly reveals that outcome representations are acquired when one learns that the outcome actually follows from an action (Elsner & Hommel, 2001). Thus, according to this notion, positive reward signals should only increase motivation when the presented information (i.e. the stimulus) is represented as an outcome of an action. Specifically, only when the presentation of specific stimulus follows an action (i.e. thus serving as an outcome of an action), rather than preceding it, will an accompanying positive reward signal cause people to engage in effortful behaviour to obtain the action–outcome.

This idea was recently tested in an action–outcome learning paradigm (Marien, Aarts, & Custers, 2015), which was designed to simulate the process by which people learn to represent their actions in terms of outcomes and associate them with positive reward signals. The paradigm allowed the researchers to manipulate whether a stimulus is represented as an outcome of an action or not by letting participants press the spacebar before or after the presentation of the stimulus. The paradigm further allowed the researchers to manipulate the positive valence of stimuli by presenting positively valenced auditory stimuli central to the human nature of social reinforcement and praise (words as 'good' or 'nice'), upon visual presentation of the originally neutral stimuli. This paradigm dissociated the action–outcome learning process from the stimulus-reward (incentive) learning process to test the combined role of outcome representations and reward signal processing in motivating behaviour. This research provided initial support for the suggestion that experienced motivation for goal-directed behaviour can be enhanced by stimuli that are paired with positive reward signals, but only when they are also represented as outcomes of actions (see box 'Habit Research in Action' for a more detailed description of this research).

The Role of Goals in Habit Formation

So far, we have discussed the role of motivation in S-R behaviour, habitual skills and goals. We have illustrated that control processes are required for more complex or skillful behaviours. Furthermore, we have discussed that some outcomes may be more positively valued than others, and this is crucial for motivating goal-directed behaviour. Moreover, we have demonstrated that the motivation of goals is dependent on two basic learning mechanisms of action–outcome learning and incentive learning. However, the question remains how goals materialize by this basic learning mechanism, and whether this mechanism can help us to understand the direct impact of goals in the habit formation process.

Basically, two different lines of research in animal learning concur with the underlying learning mechanisms of goals. First, research on instrumental learning investigated the notion that performance of an instrumental action is dependent of current value of the outcome. Having hungry rats learn two different R-O relations and later pairing one of the outcomes with a toxin to reduce its value has tested this. Afterwards, it was shown that the rats displayed a strong preference for the response whose outcome was not devalued (Colwill & Rescorla, 1985). This effect of devaluation suggests that the sensory representation of the outcome is further associated with reward information in the cognitive system (Dickinson & Balleine, 1994). Furthermore, there is research on discrimination learning that demonstrates how different discriminative stimuli (S) that signal different outcomes (O) gain control over instrumental responding (R) by cueing the anticipation of the outcome (Trapold, 1970).

Bringing insights from both lines of research together helps us to understand what role goals can play in habit formation. For that, it is important to note that the capacity of stimuli to trigger instrumental responses is independent of learning an S-R relation. This has been demonstrated with the Pavlovian-to-Instrumental Transfer paradigm (PIT) in humans. In this paradigm two separate learning phases are used to form S-O and R-O relations, and even though there is no S-R relation, S does gain the capacity to trigger R. This indicates that stimuli can be learned to trigger preferences for responses that lead to money, palatable food or drug substances (e.g. Watson, Wiers, Hommel, & de Wit, 2014). The PIT paradigm thus provides an interesting way to understand how goals can emerge from basic learning processes and drive automatic habitual mechanisms when they are triggered by stimuli that are associated with the same outcomes.

Future Directions for Research on Habits

As we have seen, the frequent and consistent execution of a specific behaviour in a specific situation may lead to the formation of habits. Even though goals (i.e. desired outcomes) may motivate the execution of the behaviour initially, their role may change and even disappear completely along the way. Determining whether—and if so in which way—goals play a role in behaviour is one of the biggest empirical and theoretical challenges for future research on habits.

In the devaluation studies discussed above (e.g. Dickinson & Balleine, 1994), it is assumed that if a devaluation of the goal changes the behaviour, this is evidence that the behaviour is non-habitual. Although devaluation tests have for long been considered the gold standard for distinguishing between habitual and other forms of behaviour, there are several issues that need to be considered in the light of our current analysis of habits.

First of all, the absence of devaluation effects does not demonstrate that goal representations are not involved in producing the effects. While these effects may demonstrate that the behaviour is not goal-directed, it could still be the case that goal representations play a role somewhere in the chain from stimulus to behaviour. For instance, even if one doesn't fancy going to work, activation of that goal representation may still facilitate the habitual cycling behaviour. Moreover, a stimulus may still remind one of an outcome and therefore facilitate the selection of the associated action, regardless of whether that action still produces it. Thus, while these tests may demonstrate the absence of goal-directed processes, they do not rule out the possibility that cognitive outcome representations are involved in producing the behavioural effects.

Second, it has recently been argued that failures to find revaluation or contingency degradation effects could also result from manipulating the wrong goals (De Houwer, Tanaka, Moors, & Tibboel, 2018). That is, if a behavioural response is driven by a goal that is higher in the hierarchical chain than the one that is manipulated, one may falsely conclude that the behaviour is habitual. Moreover, experimental tests to measure habits force instructions and goals onto people, which can be easily confused with other habitual or motivational forces. Together with the inherent problem of relying on null effects for the demonstration of goal-independent processes, there is some caution to be taken when using such tests as evidence for or against habitual behaviour.

Another point for further research pertains to the role of intentions in habitual mechanisms that involve goals. The involvement of goal representations in the chain from stimulus to behaviour does not necessarily mean the behaviour is intentional, commonly defined as a consciously set plan to act in order to attain an outcome or goal. Research on the automatic effects of goal activation suggests that these effects can occur in the absence of intentions (Custers & Aarts, 2010). While the cognitive part of an activated goal representation may trigger associated action patterns, the affective motivational part may recruit the necessary resources. As a result, behaviour may look like it is driven by intentions, but still be produced automatically as a function of stimuli that are perceived.

Although it would be extremely hard to demonstrate such nuances in real-life situations, current theoretical work in research labs may help to understand these mechanisms. The PIT paradigm, which was only recently used to study humans, has proven to be an interesting starting point for such endeavors. Although it demonstrates on the one hand that habits can be learned through separate processes of instrumental and Pavlovian learning, the role of goals is often surprising. While the paradigm rules out direct reinforcements of S-R links by rewarding outcomes and makes sure that any effects on behaviour have to be the result of the activation of the outcome representation, it has become clear that this does not always constitute goal-directed or intentional behaviour. Finding out what the exact role of goals is in this paradigm could reveal more about the functioning of habitual structures that contain outcome representations.

This raises our last point for future research, which is how people reflect on their habitual behaviour. While useful procedures have been developed that aim to tap into the subjectively reported level of automatization of habitual behaviours (Gardner, Abraham, Lally, & de Bruijn, 2012; Verplanken & Orbell, 2003; but see Verplanken et al., 1994; for potential flaws and difficulties in accessing and reporting subjective experiences of automaticity as an index of habit), the notion that a goal may be involved in this process may pose somewhat of a challenge. While

Habit Research in Action

In a recent study the process by which people learn to represent their behaviour in terms of action–outcomes was simulated (Marien et al., 2015). Specifically, participants had to frequently execute an action (pressing a key) that was either preceded or followed by an object on the computer-screen (e.g. the word 'tuba'). The object was further accompanied by a neutral or positive signal by presenting a spoken word through headphones (e.g. the word 'with' or 'nice'). Thus, the object was conceived of as an outcome of an action or not, and this action–outcome information was co-activated with a positive reward signal or not (Fig. 4.1).

After this learning phase, the motivation to control behaviour was assessed by the way people responded to the object. More specifically, the computer screen presented the object at the end of a hallway and participants were asked to move the object to the front of the hallway (i.e. closer to themselves). They could do this by pressing a specific key repeatedly. After each key press the object would move one step closer, and it required 20 key presses in total to reach the front of the hallway and complete the task (Fig. 4.2). The speed with which participants repeatedly pressed the key reflected the effort mobilized to obtain the object, because effort mobilization should result in faster repetitive action in completing the task of moving the object closer to oneself.

It was found that people who have learnt that performing an action is associated with an outcome wanted to perform the action with more effort and where quicker at completing the task. Importantly, these goal-directed motivational effects only emerged if the outcome had been linked to positive words. In sum, future research on habits can benefit from these findings because they suggest that when positive reward signals accompany the process of action-outcome learning, simple stimuli are not only able to trigger habitual responses, but can induce motivated control of goal-directed behaviour as well.

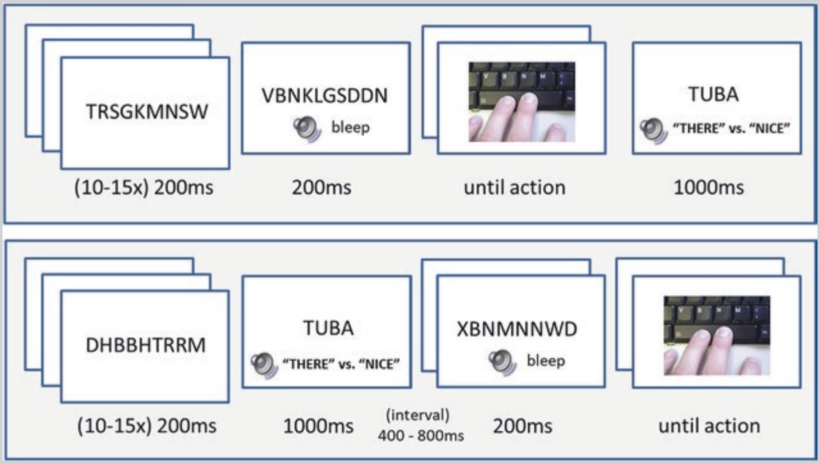

Fig. 4.1 Examples of trials in the learning phase for the outcome representation condition (top panel) and the no-outcome representation condition (bottom panel)

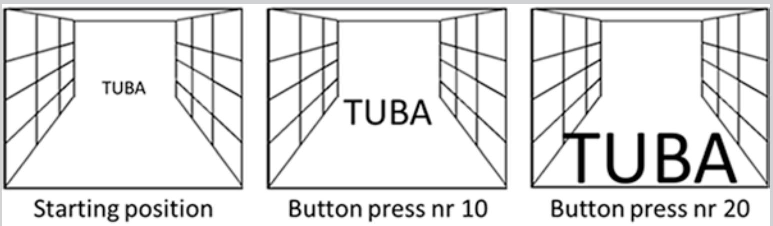

Fig. 4.2 Example of approach task in Experiment 1. A stimulus appears at the end of a hallway and participants are instructed to bring the word to the front of the hallway by pressing the down arrow key 20 times in a row

goals may be involved in automatically driving habitual behaviours, they will do so in line with people's values (Custers & Aarts, 2010). As a result, people are likely to incorrectly attribute habitual behaviours to their intentions, thus leading to an underestimation of the power of habits.

The very processes that feed our experiences of agency may further drive such misattributions. These experiences are thought to result from a match between activated outcome representations and observed behavioural effects (Aarts, Custers, & Wegner, 2005; Haggard, 2005). The finding that habitual behaviours may not just rely on the rigidity of S-R relations but could also involve S-(Outcome)-R relations, renders it likely that experiences of agency can also accompany habitual behaviours. If anything, then, people's reflections on their behaviour may also lead to an underestimation of the role of habits, which could suggest that habits may be an underestimated mode of human behaviour on which we rely much more than we realize.

References

Aarts, H., & Custers, R. (2009). Habit, action and consciousness (2009). In W. P. Banks (Ed.), *Encyclopaedia of consciousness* (Vol. 1, pp. 315–328). Oxford: Elsevier.

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. (2000). Habits as knowledge structures: Automaticity in goal-directed behavior. *Journal of Personality and Social Psychology, 78*, 53–63.

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

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). *Über den Willensakt und das Temperament*. Leipzig: Quelle & Meyer.

Adams, J. A. (1971). A closed-loop theory of motor learning. *Journal of Motor Behavior, 3*, 111–150.

Anderson, J. R., Bothell, D., Byrne, M. D., Douglass, S., Lebiere, C., & Qin, Y. (2004). An integrated theory of the mind. *Psychological Review, 111*, 1036–1060.

Bargh, J. A. (1994). The four horsemen of automaticity: Awareness, efficiency, intention, and control in social cognition. In R. S. Wyer Jr. & T. K. Srull (Eds.), *Handbook of social cognition* (2nd ed., pp. 1–40). Hillsdale, NJ: Erlbaum.

Berridge, K. C. (2001). Reward learning: Reinforcement, incentives, and expectations. In D. L. Medin (Ed.), *The psychology of learning and motivation: Advances in research and theory* (Vol. 40, pp. 223–278). San Diego: Academic Press.

Bijleveld, E., Custers, R., & Aarts, H. (2009). The unconscious eye opener pupil dilation reveals strategic recruitment of resources upon presentation of subliminal reward cues. *Psychological Science, 20*, 1313–1315.

Brown, T. L., & Carr, T. H. (1989). Automaticity in skill acquisition: Mechanisms for reducing interference in concurrent performance. *Journal of Experimental Psychology: Human Perception and Performance, 15*, 686–700.

Cleeremans, A., Destrebecqz, A., & Boyer, M. (1998). Implicit learning: News from the front. *Trends in Cognitive Sciences, 2*, 406–416.

Colwill, R. M., & Rescorla, R. A. (1985). Postconditioning devaluation of a reinforcer affects instrumental responding. *Journal of Experimental Psychology: Animal Behavior Processes, 11*, 120–132.

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.

Custers, R., & Aarts, H. (2010). The unconscious will: How the pursuit of goals operates outside of conscious awareness. *Science, 329*, 47–50.

Danner, U. N., Aarts, H., & de Vries, N. K. (2008). Habit and intention in the prediction of behaviors: The role of frequency, stability and accessibility of past behavior. *British Journal of Social Psychology, 47*, 245–265.

Davidson, D. (1980). How is weakness of the will possible? In D. Davidson (Ed.), *Essays on actions and events* (pp. 21–42). Oxford: Oxford University Press.

de Graaf, B. A. (2012). *Gevaarlijke vrouwen. Tien militante vrouwen in het vizier*. Amsterdam: Boom.

De Houwer, J., Tanaka, A., Moors, A., & Tibboel, H. (2018). Kicking the habit: Why evidence for habits in humans might be overestimated. *Motivation Science, 4*, 50–59.

Dickinson, A., & Balleine, B. (1994). Motivational control of goal-directed action. *Animal Learning & Behavior, 22*, 1–18.

Dickinson, A., & Balleine, B. (1995). Motivational control of instrumental action. *Current Directions in Psychological Science, 4*, 162-167.

Dolan, R. J. (2002). Emotion, cognition, and behavior. *Science, 298*, 1191–1194.

Elsner, B., & Hommel, B. (2001). Effect anticipation and action control. *Journal of Experimental Psychology: Human Perception and Performance, 27*, 229–240.
Fourneret, P., & Jeannerod, M. (1998). Limited conscious monitoring of motor performance in normal subjects. *Neuropsychologia, 36*, 1133–1140.
Frith, C. D., Blakemore, S. J., & Wolpert, D. M. (2000). Abnormalities in the awareness and control of action. *Philosophical Transactions of the Royal Society of London Series B, 355*, 1771–1788.
Gardner, B., Abraham, C., Lally, P., & de Bruijn, G.-J. (2012). Towards parsimony in habit measurement: Testing the convergent and predictive validity of an automaticy subscale of the self-report habit index. *International Journal of Behavioral Nutiriton and Physical Activity, 9*, 102.
Haggard, P. (2005). Conscious intention and motor cognition. *Trends in Cognitive Sciences, 9*, 290–295.
Heckhausen, H., & Beckmann, J. (1990). Intentional action and action slips. *Psychological Review, 97*, 36.
Kelly, A. M. C., & Garavan, H. (2005). Human functional neuroimaging of brain changes associated with practice. *Cerebral Cortex, 15*, 1089–1102.
Marien, H., Aarts, H., & Custers, R. (2013). Adaptive control of human action: The role of outcome representations and reward signals. *Frontiers in Psychology, 4*, 602.
Marien, H., Aarts, H., & Custers, R. (2015). The interactive role of action-outcome learning and positive affective information in motivating human goal-directed behavior. *Motivation Science, 1*, 165–183.
Maturana, H. R., & Varela, F. G. (1987). *The tree of knowledge*. Boston: Shambhala.
Miller, G. A., Galanter, E., & Pribram, K. H. (1960). *Plans and the organization of behavior*. New York: Holt, Rinehart and Winston.
Norman, D. A., & Shallice, T. (1986). Attention and 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.
O'Doherty, J. P. (2004). Reward representations and reward-related learning in the human brain: Insights from neuroimaging. *Current Opinion in Neurobiology, 14*, 769–776.
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.
Pashler, H., Johnston, J. C., & Ruthruff, E. (2001). Attention and performance. *Annual Review of Psychology, 52*, 629–651.
Plato. (380BC/1986). Protagoras. In B. A. F. Hubbard, & E. S. Karnofsky (Trans.), *The dialogues of Plato*. New York: Bantam Books.
Powers, W. T. (1973). *Behavior: The control of perception*. Chicago: Aldine.
Reason, J. (1979). Actions not as planned: The price of automatization. In G. Underwood & R. Stevens (Eds.), *Aspects of consciousness* (pp. 67–89). London: Academic Press.
Rescorla, R. A. (1976). Stimulus generalization: Some predictions from a model of Pavlovian conditioning. *Journal of Experimental Psychology: Animal Behavior Processes, 2*, 88–96.
Rescorla, R. A. (1990). The role of information about the response-outcome relation in instrumental discrimination learning. *Journal of Experimental Psychology: Animal Behavior Processes, 16*, 262–270.
Rescorla, R. A., & Wagner, A. R. (1972). A theory of Pavlovian conditioning: Variations in the effectiveness of reinforcement and nonreinforcement. In *Classical conditioning II: Current research and theory* (Vol. 2, pp. 64–99). New York: Appleton-Century-Crofts.
Skinner, B. F. (1953). *Science and human behavior*. Oxford: Macmillan.
Squire, L. R., Knowlton, B., & Musen, G. (1993). The structure and organization of memory. *Annual Review of Psychology, 44*, 453–495.
Thorndike, E. L. (1933). A proof of the law of effect. *Science, 77*, 173–175.
Trapold, M. A. (1970). Are expectancies based upon different positive reinforcing events discriminably different? *Learning and Motivation, 1*, 129–140.

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., Aarts, H., van Knippenberg, A., & van Knippenberg, C. (1994). Attitude versus general habit: Antecedents of travel mode choice. *Journal of Applied Social Psychology, 24*, 285–300.

Verplanken, B., & Orbell, S. (2003). Reflections on past behavior: A self-report index of habit strength. *Journal of Applied Social Psychology, 33*(6), 1313–1330.

Watson, J. B. (1925). *Behaviorism*. New York: The People's Institute.

Watson, P., Wiers, R. W., Hommel, B., & de Wit, S. (2014). Working for food you don't desire. Cues interfere with goal-directed food-seeking. *Appetite, 79*, 139–148.

Wegner, D. M., & Bargh, J. A. (1998). Control and automaticity in social life. In D. T. Gilbert & S. T. Fiske (Eds.), *The handbook of social psychology* (Vol. 2, 4th ed., pp. 446–496). Boston: McGraw-Hill.

Wiener, N. (1948). Cybernetics. *Scientific American, 179*, 14–19.

Zedelius, C. M., Veling, H., & Aarts, H. (2011). Boosting or choking—How conscious and unconscious reward processing modulate the active maintenance of goal-relevant information. *Consciousness and Cognition, 20*, 355–362.

Zedelius, C. M., Veling, H., Custers, R., Bijleveld, E., Chiew, K. S., & Aarts, H. (2014). A new perspective on human reward research: How consciously and unconsciously perceived reward information influences performance. *Cognitive, Affective, & Behavioral Neuroscience, 14*, 493–508.

Chapter 5
Habit Mechanisms and Behavioural Complexity

Barbara Mullan and Elizaveta Novoradovskaya

Introduction

Habit and Behaviour

Every day we engage in a series of behaviours that impact ourselves and the world around us. Unfortunately, the impact of a lot of these behaviours is negative. The food we eat, the way we travel, and the energy we consume, all contribute to national and global problems and can have detrimental effects on our health and well-being, on our environment and on the economy. Habit and its interaction with behaviour has been extensively explored in health, environmental and social psychology. With non-communicable diseases on the increase, in large part because of our habitual behaviours (Kontis et al., 2014), there has been an increase in studies to understand and change behaviour in health psychology. In environmental science, the issue of climate change and the way human behaviour contributes to it is one of the most acute issues facing the world. A significant part of the problem is the unsustainable everyday habitual behaviours in which we engage. From throwing recyclable materials into the general rubbish bin, to buying heavily packaged food and leaving the lights on at home, our everyday actions have serious consequences. Compared to health and environmental behaviours, social behaviours as habitual behaviours have been underexplored. Those that have been researched include the use of social media, volunteering, and voting. These three areas of behaviour will be explored below in relation to the concept of complexity, the role habit in predicting of behaviour, habit-based interventions, and future directions for research and intervention design will be suggested.

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What Is Complexity?

Human behaviour is incredibly complex, and in order to be able to understand the drivers of our actions and find ways to change them, consideration of the concept of behavioural complexity is warranted. For some behaviours this may seem relatively straightforward; you can argue that eating a snack bar at your desk is simple, whereas incorporating exercise into your daily routine is complex. Chocolate bars are available at the checkout counters in most supermarkets, petrol stations, corner shops, and vending machines, therefore they are easy to buy and consume and the rewards are immediate. Deciding which type of physical activity to do today, whether it is going for a jog in the park, a visit to the gym or a game of soccer with friends, packing and bringing your clothes to the office, leaving on time to head for the planned routine, is a different level of behavioural complexity. Thus, any everyday behaviour one might engage in can be questioned in terms of its complexity. Recycling may appear to be a simple choice of one bin over another; however, it also needs active consideration to choose the right materials to recycle, clean them, and sometimes to look for the appropriate bin. Recycling also requires effort, and the rewards such as a reduction in landfill, may be distal. What may appear to be simple behaviours such as consuming fruit and vegetables may in fact be complex as they involve not only multiple small linked actions, but multiple sequences of behaviours, for example, knowledge of what to buy, how to prepare, how to cook, etc. Therefore we believe it would be helpful to define complexity across certain dimensions and constructs, a simple classification which we provide below. While many researchers mention the role of complexity in habitual behaviour (Kaushal, Rhodes, Meldrum, & Spence, 2017; Knussen & Yule, 2008; Lally, Van Jaarsveld, Potts, & Wardle, 2010; Verplanken, 2006; Wood & Rünger, 2016), most have not defined it. Additionally many describe it as comparable to other constructs (e.g. perceived behavioural control) or have addressed it intuitively rather than in an evidence-based manner.

We believe that classification of behaviour into different categories across a number of dimensions will facilitate our understanding of the role of habit and goal-directed behaviours in changing and maintaining behaviour. To this end, we briefly outline previous classification attempts before proposing a simple two-axes classification that we will use to explore habit mechanisms and behavioural complexity in health, environmental and social behaviours.

Classifications of Behaviour

In the area of health psychology, a taxonomy of various behaviours has been proposed by McEachan, Lawton, and Conner (2010) who created a comprehensive analysis and classification of various health behaviours. Eleven characteristics of health behaviours emerged. These characteristics loaded onto three factors: (1) easy behaviours with immediate pay-off versus effortful behaviours with long-term pay-off; (2) private unproblematic behaviours versus public and problematic behaviours; (3) unimportant one-off behaviours versus important routines. However, for our purpose in understanding habit mechanisms and behavioural complexity, this taxonomy is incomplete as it uses routines (habits) as only one of its criteria, therefore only the second part of their third factor (routines) is of use here. Gardner, Phillips, and Judah (2016) propose a two stage model of habit formation; *instigation* and *execution*. However, while their results support this dichotomy, other research suggests that behaviours may have more than two steps, e.g. recycling (Biel, 2017). The importance of distinguishing habits of 'doing' versus habits of 'not doing' has been outlined previously (De Vries, Aarts, & Midden, 2011; Knussen & Yule, 2008), however only a handful of studies have assessed these separately, leaving the area under researched. Thus it may be that in order to establish any kind of habit, the existing habit needs to be broken down first (e.g. in order to create a habit of cycling to work, the habit of 'non-cycling' needs to be broken). Therefore, we propose that behaviours can be categorised as either *onestep* or *multistep*. The second criteria we have found to be important is immediacy of reward. We have found that the importance of past behaviour and intention differ for *immediate hedonic* versus *distal benefit* behaviours (Collins & Mullan, 2011). Thus, in the absence of a unified understanding of what a complex behaviour is (see 'Habit research in action' for a consideration of other factors that could have been used), we will focus on two key characteristics that are applicable to a range of behaviours that are performed regularly and where changing them would have a positive effect on individual, societal, and global health and well-being. These are: *the number of steps in a behavioural sequence (onestep* versus *multiple steps)* and *the outcome of the behaviour (immediate hedonic* versus *distal benefit)*. These two characteristics are important in a practical sense for implementing behaviour change interventions. Complexity, in this context is taking a 'common sense' approach: a behaviour such as tooth brushing can be considered a simple, onestep action, as it involves the same short sequence of actions, it is performed every day, and is automatic due to frequent repetition and is an immediate hedonic behaviour (fresh minty breath). Consuming a healthy diet on the other hand, can be considered a multistep behaviour as decisions have to be made about what foods are healthy, they need to be bought, cooked and consumed more than once a day and a variety of different foods need to be incorporated. Furthermore, the rewards are more distal, as a healthy diet may not be as tasty as eating fast food but long-term will assist in living a healthier life. In the remainder of this chapter we will explore a variety of behaviours based on these characteristics. In Fig. 5.1 examples of these behaviours within this classification are illustrated.

Predicting Onestep Hedonic Behaviours

In health psychology there are many behaviours that can be categorised as onestep hedonic behaviours. For example, eating or skipping breakfast (Wong & Mullan, 2009), is a onestep hedonic behaviour.[1] In this study, habit (measured as past

[1] However, if we were to consider only healthy breakfast consumption vs. unhealthy breakfast then we may need to re-categorise it as multistep and distal benefit (i.e. preparing a healthy breakfast of bircher muesli involves many steps whereas buying a doughnut in the café outside your office is a onestep behaviour, and the rewards may be equally varying).

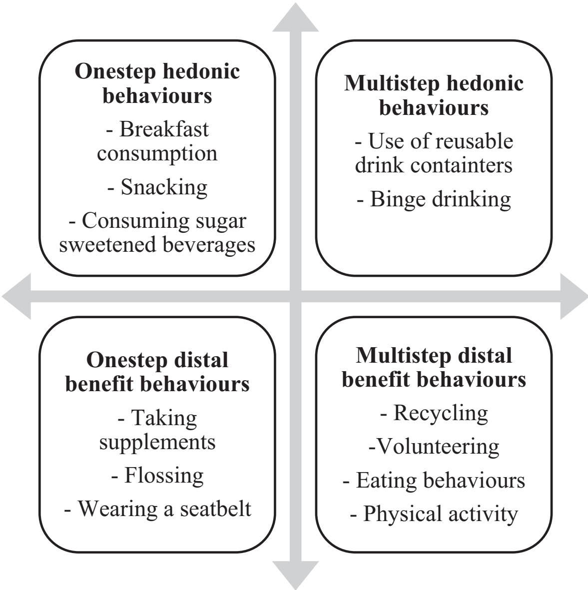

Fig. 5.1 Behaviour classification based on number of steps and outcome of behaviour with examples (*X* axis ranges from onestep to multistep behaviour; *Y* axis ranges from hedonic to distal benefit behavioural outcomes)

behaviour) was the most important predictor of behaviour and when habit was strong, intention to perform the behaviour was no longer important. Similarly in relation to unhealthy snacking, habit strength was found to be the most important predictor of behaviour (Verhoeven, Adriaanse, Evers, & de Ridder, 2012) and indeed other variables were unimportant when habit was strong. This pattern of results was also replicated in two studies of unhealthy eating habits whereby habit was found to be more important than any of the other variables measured (Collins & Mullan, 2011; Naughton, McCarthy, & McCarthy, 2015). Finally, in relation to sugar sweetened beverage consumption, habit was found to be the most important predictor of behaviour (de Bruijn & van den Putte, 2009). These predictive studies are particularly important as they demonstrate that for onestep hedonic behaviours, the most important predictor of behaviour is habit. As most interventions that attempt to change them focus on more rational processes this may explain why these behaviours are difficult to change in the long-term and why efforts to change behaviour have been met with differing degrees of success (Hebden, Chey, & Allman-Farinelli, 2012). It is suggested that behaviour change is often not maintained in the long run because the underlying habitual action driving behaviour has only been interrupted, not broken (Kwasnicka, Dombrowski, White, & Sniehotta, 2016). We will explore this further in the intervention section below.

Oulasvirta, Rattenbury, Ma, and Raita (2012) found that habit was a strong predictor of smartphone use behaviour (basic tapping and scrolling); Mouakket (2015) implicated a strong role for habit in Facebook use; and Hsiao, Chang, and Tang (2016) found habit to be predictive of use of social media apps. All these behaviours have been found to give immediate pleasure, are easy to perform and involve little effort. However, many negative consequences of social media use have been identified (see Best, Manktelow, & Taylor, 2014, for a review) and thus interventions to reduce use are needed. In terms of environmental behaviours, we were not able to identify any studies that address behaviours with immediate hedonic reward that were onestep. It could be argued that perhaps some immediate gratification is obtained after recycling (which could be in some circumstances a onestep habit); however, it is unlikely that this persists continuously. There are a few initiatives implemented in the community, such as installation of 'Return and Earn' machines (Welcome to Return and Earn, 2018), where you can return recyclable drinking containers and receive reimbursement. Similar initiatives have been implemented at some music festivals, where individuals receive their gold coin deposit back if they return their drink container (e.g. Roskilde Guide, 2018).

Predicting Multistep Hedonic Behaviours

One hedonic multistep behaviour is binge drinking. In comparison to consuming a single snack, binge drinking includes more decisions such as where to drink (home vs. pub, etc.), whether to preload, how to get home if unable to drive, who to drink with, what to drink, how many drinks and so on. Research on binge drinking has found that behaviour was independently predicted by both habit and intention (Black, Mullan, & Sharpe, 2017; Norman, 2011) with no interactions between them. This is in contrast to the onestep hedonic behaviours outlined above where only habit strength seemed important in predicting behaviour. Research on other multistep hedonic behaviours is scarce. Some examples of potential behaviours of interest may include sleep; in two of our studies with past behaviour we did find it was an important predictor of behaviour (Kor & Mullan, 2011; Todd & Mullan, 2013); and environmental behaviours such as using reusable drink containers, as they are multistep (cleaning the container, remembering to take it, washing it after) and offer immediate benefits in the form of, for example, saving money by receiving a discount.

Predicting Onestep Distal Benefit Behaviours

In comparison to the behaviours explored above, the behaviours in this section are those where benefits are more distal. One such behaviour is supplement use (Allom, Mullan, Clifford, Scott, & Rebar, 2018). In this study, habit accounted for a significant proportion of variance over and above intention. However, habit did not moderate the relationship between behaviour and intention for supplement use, suggesting that both intention and habit are essential. This is important as it suggests that there are differences in the predictors of onestep hedonic and onestep distal benefit behaviours, whereby behaviours with more distal benefits are still driven by both motivational and habitual processes. Marta, Manzi, Pozzi, and Vignoles (2014), found that intention explained only 7% of variance in volunteering behaviour, but the predictive ability of the model significantly improved by adding habit. Further evidence can be found in research by Judah, Gardner, and Aunger (2013) and Gregory and Leo (2003) who found that habit was important in flossing behaviour and water conservation respectively. Similarly in the area of voting research habit has been found to be an important predictor but motivational variables have not been measured (Cebula, Durden, & Gaynor, 2008). Unfortunately, as intention was not measured, it is not possible to determine its role in predicting these onestep distal benefit behaviours, suggesting a potential future research area.

Predicting Multistep Distal Behaviours

One health behaviour that can be determined as multistep and distal benefit is that of sun protection behaviours. While sunscreen use may be a onestep distal benefit behaviour, sun protection behaviours on the other hand are multistep. In Australia, sun protection behaviours include using SPF30 + sunscreen, wearing protective clothing such as a hat, long-sleeved shirt and sunglasses, and seeking shade during peak hours of the day (between 10 a.m. and 3 p.m.; Sinclair, 2009). In a recent study of sun protection behaviours, intention and habit predicted substantial variance in behaviour and in addition, habit moderated the intention–behaviour gap such that individuals with higher levels of habit were likely to carry out the behaviour despite their intentions while those with lower habit strength were more likely to perform the behaviour if they intended to (Allom, Mullan, & Sebastian, 2013). In a study of physical activity Rhodes, de Bruijn, and Matheson (2010) found that habit explained an additional 7% of variance on top of theory of planned behaviour components including intention; these authors also found a three-way interaction between intention, habit and behaviour, indicating that habit was stronger among those with high intentions to exercise, and weaker among non-intenders. In another study of physical activity in children a similar pattern of results emerged, whereby intention and habit were significant predictors of behaviour, and there was an interaction between them (Kremers & Brug, 2008). Likewise, in relation to fruit consumption, De Bruijn (2010) found that habit and intention were predictive of behaviour while there was also a significant interaction. The habitual use of cars, public transportation, and other modes of transport have been extensively researched both because transport is one of the largest contributors to dangerous emissions and because active commuting has such positive health benefits. In a systematic review of the cognitive mechanisms influencing choice of transport mode, Hoffmann, Abraham, White, Ball, and Skippon (2017) established that while many variables were important (including attitudes), habit and intention were strong predictors of car use and were predictive of alternative mode of travel choice. Gardner and Abraham (2008) in their meta-analysis generated a comparable pattern of results looking specifically at car use. Verplanken, Aarts, Knippenberg, and Moonen (1998) in an earlier study found interaction effects such that intention was no longer predictive of behaviour when habit was strong. More recently, Gardner (2009) demonstrated a similar finding in two studies examining habitual car and bicycle users. He found that habit moderated the intention–behaviour relationship, and intention predicted behaviour only when habit was weak.

In essence, these results appear to be analogous to those that we have reported above regarding onestep distal benefit behaviours. That is, both intention and habit are important in predicting behaviour but while in onestep distal benefit behaviours only intention and habit strength predicted behaviour, here we see an integration effect whereby if intention is low, strong habits could act in compensatory ways and vice versa. This suggests that strengthening either could be important in changing behaviour. In addition, a further important distinction is that multistep behaviours appear to take longer to form. One of the very first habit formation interventions found that simpler behaviours became habitual quicker than more complex ones (Lally et al., 2010).

Interventions in Habitual Behaviours

Based on our proposed classification scheme, when designing interventions to change behaviour we need to consider whether the behaviour is onestep or multistep and/or hedonic or distal benefit. Interventions that do not consider these factors may not be as successful as they could be. Aarts and Dijksterhuis (2000) conducted an experiment where participants had to name a habitual mode of transport to a particular destination (e.g. to their University) in one condition, or name an alternative mode of transport in another condition. Under cognitive load (a task to sum numbers) participants were much less successful in inhibiting the habitual response (naming an alternative mode of transport). These findings suggest that even if we would like to perform an alternative action as opposed to a habitual one (e.g. take a bicycle to work instead of a car),

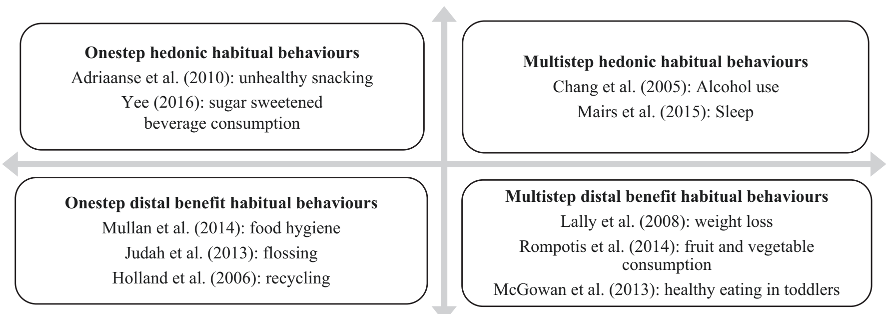

Fig. 5.2 Behaviours targeted in interventions based on number of steps and outcome of behaviour (*X* axis ranges from onestep to multistep behaviour; *Y* axis ranges from hedonic to distal benefit behavioural outcomes)

it might be difficult when cognitive resources are low (e.g. having to think about an upcoming work meeting or preparing kids for school) (Fig. 5.2).

Interventions Targeting Onestep Hedonic Behaviours

Adriaanse et al. (2010) used a combination of mental contrasting and implementation intentions in a habit-based intervention to successfully reduce unhealthy snacking. The authors argued that the reason mental contrasting may be so successful is that it compels participants to focus on the cues that lead to the behaviour and thus consider ways of avoiding these cues. Similarly, in an intervention to reduce sugar sweetened beverage consumption Yee (2016) targeted habits with implementation intentions to identify when the beverage was most commonly consumed and to replace it with a healthy alternative. Participants successfully replaced their sugar sweetened beverage consumption with water or a sugar-free soft drink. In both instances a hedonic behaviour was replaced with another, healthy behaviour.

Interventions Targeting Multistep Hedonic Behaviours

While we have been unable to identify many studies in this category that were explicitly based on habit theory, one of our previous studies used self-monitoring or implementation intentions to target sleep hygiene (a behaviour consisting of various steps but bringing an immediate benefit of rest) and found small to medium effects across the different sleep hygiene behaviours (e.g. making sleep environment restful, avoiding going to bed hungry or thirsty; Mairs & Mullan, 2015). These techniques have been frequently used to target habitual behaviours, therefore supporting the likelihood that habit-based interventions could be effective. Additionally, a brief intervention utilised implementation intentions to target prenatal alcohol use and found significant reductions in alcohol consumption at postpartum follow-up, as measured by the National Institute on Alcohol Abuse and Alcoholism quantity-frequency questions and the Health Habits survey (Chang et al., 2005).

Interventions Targeting Onestep Distal Benefit Behaviours

Mullan, Allom, Fayn, and Johnson (2014) designed a habit-based intervention aimed at developing the habit of microwaving one's dishcloth. A dishcloth is one of the most unhygienic items in a household and is implicated in many food poisoning outbreaks (Borrusso & Quinlan, 2017). Research has shown the most effective way of cleaning it is to microwave it (Sharma, Eastridge, & Mudd, 2009; Taché & Carpentier, 2014). A salient cue and self-monitoring techniques were offered to the participants. Using the Self-Report Habit Index (Verplanken & Orbell, 2003) it was evident that participants developed a habit and maintained it at follow-up. Furthermore, behaviour changed in the intervention group compared to the control group and the change in behaviour was mediated by change in habit strength. In a habit formation intervention in flossing behaviour, Judah et al. (2013) used a combination of implementation intentions and cues to action (floss before vs. after tooth-brushing) to successfully change behaviour and found that those who flossed after brushing had a stronger habit to floss, suggesting that the context of the cue is also important. Holland, Aarts, and Langendam (2006) conducted an intervention where a multistep recycling behaviour was transformed into a onestep behaviour by removing the preparation and decision making stages (e.g. no need to prepare the rubbish for the bin; the bin being suitable only for one type of materials). Participants were randomly assigned to an implementation intentions group, a group that had a salient cue (a recycling bin nearby their desk) and a control group. The amount of recyclable materials in the regular waste basket was manually counted every night. In weeks one and two and two months after manipulation, both implementation intentions and salient recycling facility groups increased their habit and behaviour of recycling compared to the control group. This suggests that context modification (in the form of adding a recycling facility, that serves as a cue to recycle) and creating specific plans for recycling both can assist in breaking habits of non-recycling and creating ones of recycling.

Interventions Targeting Multistep Distal Benefit Behaviour

In an intervention targeting weight loss Lally, Chipperfield, and Wardle (2008) designed a simple advice leaflet based on a habit-formation model. This and a self-monitoring tool were provided to participants. Significant weight loss was reached at post-intervention and follow-up for the intervention group compared to the control group. McGowan et al. (2013) utilised a randomised controlled trial involving habit training with a group of parents of children aged 2–6 and incorporated habit formation in a dietary intervention. Parents in the intervention group demonstrated an increase in their habit strength, and reported improvements in their child's diet across the dietary behaviours of interest (McGowan et al., 2013). Importantly, it was found that gains had either maintained or increased over time at two-month follow-up (Gardner, Sheals, Wardle, & McGowan, 2014).

Rompotis, Grove, and Byrne (2014) found that habit-based intervention messages successfully increased fruit consumption, but vegetable consumption increased regardless of whether the target was automatic or rational processes. This is particularly important as it supports the results of previously mentioned predictive research where it has been demonstrated that for multistep distal benefit behaviours both intention and habit are predictors of behaviour. Interestingly, a habit-based intervention aimed at reducing sedentary behaviour (White et al., 2017) was unsuccessful at changing behaviour compared to the control (both groups improved) and it is unclear in what ways this differed from the successful ones. It may be that there is a 'file drawer' in effect whereby other interventions that have not been successful have not been published. It is important researchers share their null findings in order to gain a more comprehensive understanding of when habit-based interventions are successful.

Behaviour Change Techniques Used in Interventions

We reviewed the interventions above, which were determined by their authors to be habit-based, in terms of the behaviour change techniques used (See Michie et al., 2013, for full details). We identified six clusters of techniques that were repeatedly used (see Table 5.1). The first of these is 'goals and planning' (e.g. Judah et al., 2013), whereby interventions focus on techniques that allow individuals to determine what it is they want to change and what goal they are working towards. While not specifically related to habit formation or reversal, this is important as without setting smart goals or action planning it is very difficult for individuals to know what outcome they are aiming to achieve. The second and third clusters are 'feedback and monitoring' and 'shaping knowledge'. Again, while these clusters of techniques focus on rational processes so that individuals can evaluate their progress towards their goals, alone, they are unlikely to lead to habitual behaviour. The other three clusters of behaviour change techniques are those that are most closely aligned with habit theory. The first two, 'antecedents' and 'associations' involve providing or reducing cues and changing the environment. The final cluster 'repetition and substitutions' specifically targets habit formation and reversal. All three of these clusters are particularly important for breaking old habits or forming new ones and allow individuals to build on the behaviour changes they have made. Designing habit-based interventions that incorporate these behaviour change techniques will likely increase the success of those interventions, as well as allowing for a more rigorous evaluation of their effectiveness (e.g. application of meta-analytic methods).

Conclusions and Future Directions

We have outlined above the reasons why we believe that it is important to consider behavioural complexity and habit. Using our classification we showed that onestep hedonic behaviours are primarily predicted by habit; onestep distal benefit behaviours are predicted by habit and intention; multistep hedonic and distal benefit behaviours are predicted by habit and intention but only in distal benefit behaviours is there an interaction between habit and intention. Onestep behaviours appear to take a shorter period of time to become habitual whereas multistep behaviours are likely to take longer to become habitual. While this classification is novel in its conception and is in need of empirical testing (see the 'Research in Action' box), it

Table 5.1 Interventions targeting various habitual behaviours, including targeted behaviour, behaviour change techniques used, contents of the intervention, its length and complexity (number of steps and outcome of behaviour)

Author	Behaviour	Behaviour change techniques	Contents of intervention	Length	Number of steps	Outcome of the behaviour
Adriaanse et al. (2010)	Snacking	Goals and planning (Action planning and Discrepancy between current behaviour and goal) Feedback and monitoring (Self-monitoring of behaviour) Natural consequences (Information about health consequences)	Mental contrasting Forming implementation intentions about snacking	1 session	Onestep	Hedonic
Yee (2016)	Sugar sweetened beverages	Goals and planning (Action planning) Natural consequences (Information about health consequences) Repetition and substitution (Behaviour substitution)	Basic information regarding diet drinks and water, implementation intention planning exercise, personalised implementation intention creations (writing it down), weekly email reminders of study commitments and SSB information	8 weeks	Onestep	Hedonic
Holland et al. (2006)	Recycling	Goals and planning (Action planning and Behavioural contract) Repetition and substitution (Habit formation) Antecedents (Adding objects to the environment)	Form implementation intentions about recycling, and then provided with a special recycling bin close to desk	8 weeks	Onestep	Distal benefit
Judah et al. (2013)	Flossing	Goals and planning (Goal setting (behaviour) and Action planning) Feedback and monitoring (Self-monitoring of behaviour) Shaping knowledge (Instruction on how to perform the behaviour) Associations (Prompts/cues) Repetition and substitution (Habit formation)	Meeting with participants, assessment of their routines, assignment to a condition, providing information on benefit of flossing, forming an implementation intention, writing it down and learning it. SMS reminders	1 session	Onestep	Distal benefit

(continued)

Table 5.1 (continued)

Author	Behaviour	Behaviour change techniques	Contents of intervention	Length	Number of steps	Outcome of the behaviour
Mullan, Allom, Fayn, and Johnson (2014)	Food safety behaviour	Shaping knowledge (Instruction on how to perform the behaviour) Natural consequences (Information about health consequences) Associations (Prompts/cues) Repetition and substitution (Habit formation) Antecedents (Adding objects to the environment)	Poster, information about benefits of sponge microwaving, email reminders with SRHI. Sponge was given out as well	3 weeks	Onestep	Distal benefit
Chang et al. (2005)	Alcohol use	Goals and planning (Goal setting (behaviour) and Action planning) Natural consequences (Information about health consequences) Social support (Social support (practical))	Review of the healthy pregnancy facts knowledge measure, goal setting and contracting, and forming implementation intentions for alcohol use	1 session	Multistep	Hedonic
Rompotis et al. (2014)	Fruit and vegetable consumption among young adults	Natural consequences (Information about emotional consequences) Associations (Prompts/cues) Repetition and substitution (Habit formation) Antecedents (Restructuring the physical environment) Covert learning (Imaginary reward)	Email/SMS messages with habit-based prompts	8 weeks	Multistep	Distal benefit

Lally et al. (2008)	Weight loss	Goals and planning (Goal setting (behaviour) and Action planning) Feedback and monitoring (Monitoring of behaviour by others without feedback, Self-monitoring of behaviour, Self-monitoring of outcome(s) of behaviour) Shaping knowledge (Instruction on how to perform the behaviour) Repetition and substitution (Habit formation) Associations (Prompts/cues) Antecedents (Adding objects to the environment)	At baseline a leaflet with 10 tips on seven simple behaviours, simple daily monitoring form with space for notes and plans and weight records were given out. Weight measured weekly, after 8 weeks monthly for 6 months	8 weeks	Multistep	Distal benefit
McGowan et al. (2013)	Parental feeding of their children	Goals and planning (Goal setting (behaviour) and Action planning) Feedback and monitoring (Self-monitoring of behaviour) Shaping knowledge (Instruction on how to perform the behaviour) Associations (Prompts/cues) Repetition and substitution (Habit formation)	Four sessions with researcher, booklet, tips, discussions, goal-setting (parent)	4 sessions	Multistep	Distal benefit
Comber and Thieme (2013)	Recycling and food-waste behaviour	Feedback and monitoring (Monitoring of behaviour by others without feedback and Feedback on behaviour) Comparison of behaviour (Social comparison) Reward and threat (Non-specific reward) Antecedents (Adding objects to the environment)	Install bin cam (camera on the inside of the bin lid) in the household, app on FB where pictures of trash are put, social interaction, rewards	5 weeks	Multistep	Distal benefit

(continued)

Table 5.1 (continued)

Author	Behaviour	Behaviour change techniques	Contents of intervention	Length	Number of steps	Outcome of the behaviour
White et al. (2017)	Sedentary behaviour reduction	Goals and planning (Goal setting (behaviour) and Action planning) Feedback and monitoring (Self-monitoring of behaviour and Self-monitoring of outcome(s) of behaviour) Shaping knowledge (Instruction on how to perform the behaviour)\Natural consequences (Information about health consequences) Comparison of behaviour (Demonstration of the behaviour) Associations (Prompts/cues) Repetition and substitution (Behaviour substitution; Habit formation; Habit reversal and Graded tasks) Antecedents (Restructuring the physical environment and Adding objects to the environment) Identity (Framing/reframing)	Printed A5-sized information booklet outlining the health impact of sedentary behaviour (SB) and physical activity (PA) and 15 tips on reducing SB and forming PA habits. Where possible, tips specified an everyday cue. A daily adherence record sheet	12 weeks	Multistep	Distal benefit

gives researchers a starting point to explore different approaches to designing interventions. This classification scheme goes some way towards explaining the variation in patterns of results found in predictive studies of behaviour. Therefore, we think it is important that researchers consider these aspects when designing interventions in future studies.

While this classification of complexity appears useful in understanding predictive studies, as there is a dearth of habit-based interventions it is too soon to see if it will hold up when exploring interventions. However, based on the studies reviewed, specifically in relation to onestep hedonic behaviours, our classification system would suggest that only habit needs to be targeted. However, the two interventions that targeted onestep hedonic behaviours used behaviour change techniques aimed at changing both rational and automatic processes (Adriaanse et al., 2010; Yee, 2016). Therefore, researchers could consider reducing the number of techniques used or shortening the length of these interventions as it may be one of the areas whereby behaviour can be changed more easily.

Further, our understanding of how complexity relates to intervention design is also complicated as most of the interventions reviewed use a combination of behaviour change techniques aimed at changing both habitual and non-habitual processes, even though the intervention authors perceived them to be habit-based. One solution in future research is to use full factorial designs where behaviour change techniques that target habitual and non-habitual processes are varied which would allow us to disentangle the importance of each across the four different categories of behaviour. Furthermore, a particular area where interventions are needed is social media use. There is a serious paucity of existing interventions in this area despite the volume of research exploring its predictors and consequences. Therefore, there is an opportunity here for habit researchers to design studies that can concentrate on either decreasing the immediate gratification by working with social networks to reduce the rewards for posting content or by increasing the number of steps involved in the behaviour such as making logging on more difficult.

Going forward, more research focusing on interventions targeting different behaviours is needed so that across the different areas of classification (see Fig. 5.1) and the different behaviour change techniques (Table 5.1) it can be determined if some techniques work better than the others. Much of the predictive research reviewed used short time periods between time one and time two, thus future research needs to look at longitudinal studies as the importance of habit and intention vary longitudinally (Sheeran, Godin, Conner, & Germain, 2017). This may have implications for interventions looking at maintenance of behaviour (Kwasnicka et al., 2016) and more research is required. Additionally, the role of

Habit Research in Action

The problem of behavioural complexity is, ironically, a complex one, especially when considered within the context of habitual behaviours. The idea of complexity as a combination of (1) the number of steps needed to enact the behaviour and (2) the timing of the benefits obtained, was taken here, partly as the evidence seemed to suggest that these two factors are important in habit formation (see main text), but also in order to look at complexity from a practical point of view to strengthen the effectiveness of behaviour change interventions. While these two factors struck us as most important we also considered a large number of other potential criteria that could be taken into account when looking at forming new habits or breaking old ones. Below are some examples:

1. There is a difference between 'a habit of doing' versus 'a habit of not doing' (De Vries et al., 2011; Knussen & Yule, 2008). For example, those who are not used to wearing a seatbelt do not just have no habit of wearing a seatbelt, they also have a habit of not wearing a seatbelt. However, very few studies have actively explored this.
2. Another dimension worth investigating might be approach and avoidance habits. We found that the role of intention and self-regulation differed in importance for eating fruit and vegetables (approach behaviours) vs. avoiding saturated fat (an avoidance behaviour) (Mullan, Allom, Brogan, Kothe, & Todd, 2014) and this may follow for the role of habit in these common behaviours as well.
3. The importance of habit differs in 'supportive' environments, i.e. where participants found the environmental cues supported maintenance of a healthy lifestyle, in contrast to those who found their environment to be unsupportive to living a healthy lifestyle (Booker & Mullan, 2013). For example, having fruit available for purchase in a café downstairs would be a supportive environment to make healthier snack choices, whereas a vending machine with unhealthy snacks would be unsupportive.
4. The role of choice has been explored in rational decision making (Verhoeven, Adriaanse, Ridder, Vet, & Fennis, 2013). Results showed that choice impedes the effectiveness of implementation intentions and therefore it may have an important role to play in attempts to change habitual behaviour.

This is not an exhaustive list as there are a wide variety of other factors that could be considered such as behaviours performed weekly or more frequently vs. yearly or less commonly (Ouellette & Wood, 1998) and intrinsically motivated vs. not (Gardner & Lally, 2013), among others. Going forward we need to consider whether these need to be studied when attempting to develop habit-based interventions, whether different behaviour change techniques could address these elements or whether, for certain behaviours, targeting only habit is likely to be ineffective.

habit as a mediator of behaviour change needs to be more frequently reported as even when interventions are successful in changing behaviour, we need to understand the mechanisms by which this occurs. Finally, development of the ideas around behavioural complexity and habit mechanisms has just begun and we anticipate continued growth of interest in this area.

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References

Aarts, H., & Dijksterhuis, A. (2000). The automatic activation of goal-directed behaviour: The case of travel habit. *Journal of Environmental Psychology, 20*(1), 75–82. https://doi.org/10.1006/jevp.1999.0156

Adriaanse, M. A., Oettingen, G., Gollwitzer, P. M., Hennes, E. P., De Ridder, D. T., & De Wit, J. B. (2010). When planning is not enough: Fighting unhealthy snacking habits by mental contrasting with implementation intentions (MCII). *European Journal of Social Psychology, 40*(7), 1277–1293. https://doi.org/10.1002/ejsp.730

Allom, V., Mullan, B., Clifford, A., Scott, A., & Rebar, A. (2018). Understanding supplement use: An application of temporal self-regulation theory. *Psychology, Health & Medicine, 23*(2), 178–188. https://doi.org/10.1080/13548506.2017.1339893

Allom, V., Mullan, B., & Sebastian, J. (2013). Closing the intention-behaviour gap for sunscreen use and sun protection behaviours. *Psychology & Health, 28*, 477–494. https://doi.org/10.1080/08870446.2012.745935

Best, P., Manktelow, R., & Taylor, B. (2014). Online communication, social media and adolescent wellbeing: A systematic narrative review. *Children and Youth Services Review, 41*, 27–36. https://doi.org/10.1016/j.childyouth.2014.03.001

Biel, A. (2017). Environmental behaviour: Changing habits in a social context. In *Individual and structural determinants of environmental practice* (pp. 11–25). Abingdon: Routledge.

Black, N., Mullan, B., & Sharpe, L. (2017). Predicting heavy episodic drinking using an extended temporal self-regulation theory. *Addictive Behaviors, 73*(111–118), 111. https://doi.org/10.1016/j.addbeh.2017.04.017

Booker, L., & Mullan, B. (2013). Using the temporal self-regulation theory to examine the influence of environmental cues on maintaining a healthy lifestyle. *British Journal of Health Psychology, 18*(4), 745–762. https://doi.org/10.1111/bjhp.12015

Borrusso, P. A., & Quinlan, J. J. (2017). Prevalence of pathogens and Indicator organisms in home kitchens and correlation with unsafe food handling practices and conditions. *Journal of Food Protection, 80*(4), 590–597. https://doi.org/10.4315/0362-028x.jfp-16-354

Cebula, R. J., Durden, G. C., & Gaynor, P. E. (2008). The impact of the repeat-voting-habit persistence phenomenon on the probability of voting in presidential elections. *Southern Economic Journal, 75*, 429–440.

Chang, G., McNamara, T. K., Orav, E. J., Koby, D., Lavigne, A., Ludman, B., et al. (2005). Brief intervention for prenatal alcohol use: A randomized trial. *Obstetrics and Gynecology, 105*(5 Pt 1), 991.

Collins, A., & Mullan, B. (2011). An extension of the theory of planned behavior to predict immediate hedonic behaviors and distal benefit behaviors. *Food Quality & Preference, 22*, 638–646. https://doi.org/10.1016/j.foodqual.2011.03.011

Comber, R., & Thieme, A. (2013). Designing beyond habit: opening space for improved recycling and food waste behaviors through processes of persuasion, social influence and aversive affect. *Personal and ubiquitous computing, 17*(6), 1197-1210. https://doi.org/10.1007/s00779-012-0587-1

De Bruijn, G.-J. (2010). Understanding college students' fruit consumption. Integrating habit strength in the theory of planned behaviour. *Appetite, 54*(1), 16–22. https://doi.org/10.1016/j.appet.2009.08.007

de Bruijn, G.-J., & van den Putte, B. (2009). Adolescent soft drink consumption, television viewing and habit strength. Investigating clustering effects in the theory of planned behaviour. *Appetite, 53*(1), 66–75. https://doi.org/10.1016/j.appet.2009.05.008

De Vries, P., Aarts, H., & Midden, C. J. (2011). Changing simple energy-related consumer behaviors: How the enactment of intentions is thwarted by acting and non-acting habits. *Environment and Behavior, 43*(5), 612–633. https://doi.org/10.1177/0013916510369630

Gardner, B. (2009). Modelling motivation and habit in stable travel mode contexts. *Transportation Research Part F: Traffic Psychology and Behaviour, 12*(1), 68–76. https://doi.org/10.1016/j.trf.2008.08.001

Gardner, B., & Abraham, C. (2008). Psychological correlates of car use: A meta-analysis. *Transportation Research Part F: Traffic Psychology and Behaviour, 11*(4), 300–311. https://doi.org/10.1016/j.trf.2008.01.004

Gardner, B., & Lally, P. (2013). Does intrinsic motivation strengthen physical activity habit? Modeling relationships between self-determination, past behaviour, and habit strength. *Journal of Behavioral Medicine, 36*(5), 488–497. https://doi.org/10.1007/s10865-012-9442-0

Gardner, B., Phillips, L. A., & Judah, G. (2016). Habitual instigation and habitual execution: Definition, measurement, and effects on behaviour frequency. *British Journal of Health Psychology, 21*(3), 613–630. https://doi.org/10.1111/bjhp.12189

Gardner, B., Sheals, K., Wardle, J., & McGowan, L. (2014). Putting habit into practice, and practice into habit: A process evaluation and exploration of the acceptability of a habit-based dietary behaviour change intervention. *International Journal of Behavioral Nutrition and Physical Activity, 11*(1), 135. https://doi.org/10.1186/s12966-014-0135-7

Gregory, G. D., & Leo, M. D. (2003). Repeated behavior and environmental psychology: The role of personal involvement and habit formation in explaining water consumption. *Journal of Applied Social Psychology, 33*(6), 1261–1296. https://doi.org/10.1111/j.1559-1816.2003.tb01949.x

Hebden, L., Chey, T., & Allman-Farinelli, M. (2012). Lifestyle intervention for preventing weight gain in young adults: A systematic review and meta-analysis of RCTs. *Obesity Reviews, 13*(8), 692–710. https://doi.org/10.1111/j.1467-789x.2012.00990.x

Hoffmann, C., Abraham, C., White, M. P., Ball, S., & Skippon, S. M. (2017). What cognitive mechanisms predict travel mode choice? A systematic review with meta-analysis. *Transport Reviews, 37*, 1–22. https://doi.org/10.1080/01441647.2017.1285819

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*(6), 776–783. https://doi.org/10.1016/j.jesp.2005.11.006

Hsiao, C.-H., Chang, J.-J., & Tang, K.-Y. (2016). Exploring the influential factors in continuance usage of mobile social Apps: Satisfaction, habit, and customer value perspectives. *Telematics and Informatics, 33*(2), 342–355. https://doi.org/10.1016/j.tele.2015.08.014

Judah, G., Gardner, B., & Aunger, R. (2013). Forming a flossing habit: An exploratory study of the psychological determinants of habit formation. *British Journal of Health Psychology, 18*(2), 338–353. https://doi.org/10.1111/j.2044-8287.2012.02086.x

Kaushal, N., Rhodes, R. E., Meldrum, J. T., & Spence, J. C. (2017). The role of habit in different phases of exercise. *British Journal of Health Psychology, 22*(3), 429–448. https://doi.org/10.1111/bjhp.12237

Knussen, C., & Yule, F. (2008). "I'm not in the habit of recycling" the role of habitual behavior in the disposal of household waste. *Environment and Behavior, 40*(5), 683–702. https://doi.org/10.1177/0013916507307527

Kontis, V., Mathers, C. D., Rehm, J., Stevens, G. A., Shield, K. D., Bonita, R., et al. (2014). Contribution of six risk factors to achieving the 25x25 non-communicable disease mortality reduction target: A modelling study. *The Lancet, 384*(9941), 427–437. https://doi.org/10.1016/s0140-6736(14)60616-4

Kor, K., & Mullan, B. (2011). Sleep hygiene behaviours: An application of the theory of planned behaviour and the investigation of perceived autonomy support, past behaviour and response

inhibition. *Psychology & Health, 26*(9), 1208–1224. https://doi.org/10.1080/08870446.2010.551210
Kremers, S. P., & Brug, J. (2008). Habit strength of physical activity and sedentary behavior among children and adolescents. *Pediatric Exercise Science, 20*(1), 5–17. https://doi.org/10.1123/pes.20.1.5
Kwasnicka, D., Dombrowski, S. U., White, M., & Sniehotta, F. (2016). Theoretical explanations for maintenance of behaviour change: A systematic review of behaviour theories. *Health Psychology Review, 10*(3), 277–296. https://doi.org/10.1080/17437199.2016.1151372
Lally, P., Chipperfield, A., & Wardle, J. (2008). Healthy habits: Efficacy of simple advice on weight control based on a habit-formation model. *International Journal of Obesity, 32*(4), 700–707.
Lally, P., Van Jaarsveld, C. H., Potts, H. W., & Wardle, J. (2010). How are habits formed: Modelling habit formation in the real world. *European Journal of Social Psychology, 40*(6), 998–1009. https://doi.org/10.1002/ejsp.674
Mairs, L., & Mullan, B. (2015). Self-monitoring vs. implementation intentions: A comparison of behaviour change techniques to improve sleep hygiene and sleep outcomes in students. *International Journal of Behavioral Medicine, 22*(5), 635–644. https://doi.org/10.1007/s12529-015-9467-1
Marta, E., Manzi, C., Pozzi, M., & Vignoles, V. L. (2014). Identity and the theory of planned behavior: Predicting maintenance of volunteering after three years. *The Journal of Social Psychology, 154*(3), 198–207.
McEachan, R. R. C., Lawton, R. J., & Conner, M. (2010). Classifying health-related behaviours: Exploring similarities and differences amongst behaviours. *British Journal of Health Psychology, 15*(2), 347–366. https://doi.org/10.1348/135910709x466487
McGowan, L., Cooke, L. J., Gardner, B., Beeken, R. J., Croker, H., & Wardle, J. (2013). Healthy feeding habits: Efficacy results from a cluster-randomized, controlled exploratory trial of a novel, habit-based intervention with parents. *The American Journal of Clinical Nutrition, 98*(3), 769–777. https://doi.org/10.3945/ajcn.112.052159
Michie, S., Richardson, M., Johnston, M., Abraham, C., Francis, J., Hardeman, W., et al. (2013). The behavior change technique taxonomy (v1) of 93 hierarchically clustered techniques: Building an international consensus for the reporting of behavior change interventions. *Annals of Behavioral Medicine, 46*(1), 81–95. https://doi.org/10.1007/s12160-013-9486-6
Mouakket, S. (2015). Factors influencing continuance intention to use social network sites: The Facebook case. *Computers in Human Behavior, 53*, 102–110. https://doi.org/10.1016/j.chb.2015.06.045
Mullan, B., Allom, V., Brogan, A., Kothe, E., & Todd, J. (2014). Self-regulation and the intention behaviour gap: Exploring dietary behaviours in university students. *Appetite, 73*, 7–14. https://doi.org/10.1016/j.appet.2013.10.010
Mullan, B., Allom, V., Fayn, K., & Johnson, I. (2014). Building habit strength: An intervention designed to improve food-safety behavior. *Food Research International, 66*, 274–278. https://doi.org/10.1016/j.foodres.2014.09.027
Naughton, P., McCarthy, M., & McCarthy, S. (2015). Acting to self-regulate unhealthy eating habits. An investigation into the effects of habit, hedonic hunger and self-regulation on sugar consumption from confectionery foods. *Food Quality and Preference, 46*, 173–183. https://doi.org/10.1016/j.foodqual.2015.08.001
Norman, P. (2011). The theory of planned behavior and binge drinking among undergraduate students: Assessing the impact of habit strength. *Addictive Behaviors, 36*(5), 502–507. https://doi.org/10.1016/j.addbeh.2011.01.025
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*(1), 54. https://doi.org/10.1037//0033-2909.124.1.54
Oulasvirta, A., Rattenbury, T., Ma, L., & Raita, E. (2012). Habits make smartphone use more pervasive. *Personal and Ubiquitous Computing, 16*(1), 105–114. https://doi.org/10.1007/s00779-011-0412-2

Rhodes, R., de Bruijn, G.-J., & Matheson, D. H. (2010). Habit in the physical activity domain: Integration with intention temporal stability and action control. *Journal of Sport and Exercise Psychology, 32*(1), 84–98.

Rompotis, C. J., Grove, J. R., & Byrne, S. M. (2014). Benefits of habit-based informational interventions: A randomised controlled trial of fruit and vegetable consumption. *Australian and New Zealand Journal of Public Health, 38*(3), 247–252. https://doi.org/10.1111/1753-6405.12232

Roskilde Guide. (2018). Retrieved from https://www.roskilde-festival.dk/guide?food-and-beverages=refund

Sharma, M., Eastridge, J., & Mudd, C. (2009). Effective household disinfection methods of kitchen sponges. *Food Control, 20*(3), 310–313. https://doi.org/10.1016/j.foodcont.2008.05.020

Sheeran, P., Godin, G., Conner, M., & Germain, M. (2017). Paradoxical effects of experience: Past behavior both strengthens and weakens the intention-behavior relationship. *Journal of the Association for Consumer Research, 2*(3), 309–318. https://doi.org/10.1086/691216

Sinclair, C. (2009). *Skin cancer prevention: A blue chip investment in health*. Melbourne: Cancer Council Australia & The Australian College of Dermatologists.

Taché, J., & Carpentier, B. (2014). Hygiene in the home kitchen: Changes in behaviour and impact of key microbiological hazard control measures. *Food Control, 35*(1), 392–400. https://doi.org/10.1016/j.foodcont.2013.07.026

Todd, J., & Mullan, B. (2013). The role of self-regulation in predicting sleep hygiene in university students. *Psychology, Health & Medicine, 18*, 275–288. https://doi.org/10.1080/13548506.2012.701756

Verhoeven, A. A., Adriaanse, M. A., Evers, C., & de Ridder, D. T. (2012). The power of habits: Unhealthy snacking behaviour is primarily predicted by habit strength. *British Journal of Health Psychology, 17*(4), 758–770. https://doi.org/10.1111/j.2044-8287.2012.02070.x

Verhoeven, A. A., Adriaanse, M. A., Ridder, D. T., Vet, E., & Fennis, B. M. (2013). Less is more: The effect of multiple implementation intentions targeting unhealthy snacking habits. *European Journal of Social Psychology, 43*(5), 344–354. https://doi.org/10.1002/ejsp.1963

Verplanken, B. (2006). Beyond frequency: Habit as mental construct. *British Journal of Social Psychology, 45*(3), 639–656. https://doi.org/10.1348/014466605x49122

Verplanken, B., Aarts, H., Knippenberg, A., & Moonen, A. (1998). Habit versus planned behaviour: A field experiment. *British Journal of Social Psychology, 37*(1), 111–128. https://doi.org/10.1111/j.2044-8309.1998.tb01160.x

Verplanken, B., & Orbell, S. (2003). Reflections on past behavior: A self-report index of habit strength. *Journal of Applied Social Psychology, 33*(6), 1313–1330. https://doi.org/10.1111/j.1559-1816.2003.tb01951.x

Welcome to Return and Earn. (2018). Retrieved from https://returnandearn.org.au/

White, I., Smith, L., Aggio, D., Shankar, S., Begum, S., Matei, R., et al. (2017). On your feet to earn your seat: Pilot RCT of a theory-based sedentary behaviour reduction intervention for older adults. *Pilot and Feasibility Studies, 3*(1), 23. https://doi.org/10.1186/s40814-017-0139-6

Wong, C., & Mullan, B. (2009). Predicting breakfast consumption: An application of the theory of planned behaviour and the investigation of past behaviour and executive function. *British Journal of Health Psychology, 14*(3), 489–504. https://doi.org/10.1348/135910708x360719

Wood, W., & Rünger, D. (2016). Psychology of habit. *Annual Review of Psychology, 67*, 289. https://doi.org/10.1146/annurev-psych-122414-033417

Yee, M. (2016). Changing Sugary Drink Habits; investigating the effectiveness of a behavioural intervention in reducing sugar-sweetened beverage consumption by substituting with water or diet drinks. Thesis submitted in partial fulfilment of the requirements for the degree of MRes in Clinical Research (Human Nutrition) Imperial College London.

Chapter 6
Physical Activity Habit: Complexities and Controversies

Ryan E. Rhodes and Amanda L. Rebar

Introduction

The health benefits of regular physical activity participation among adults support a reliable dose–response relationship with risk reduction of all-cause mortality, cardiovascular disease, stroke, hypertension, colon cancer, and breast cancer (Warburton, Charlesworth, Ivey, Nettlefold, & Bredin, 2010). Furthermore, regular physical activity has been linked to reduced mental health problems such as depression and anxiety symptoms (Rebar et al., 2015). The recommended dose of physical activity for optimal health benefits is 150 min of moderate intensity or 75 min of vigorous intensity activity for adults per week (World Health Organization, 2012). Unfortunately, few people meet these guidelines, particularly in higher income countries (Hallal et al., 2012). For example, less than 20% of North American adults are physically active at the recommended guidelines (Colley et al., 2011; Troiano et al., 2008). Thus, promotion of regular physical activity is paramount to public health and effective interventions are needed.

By far, the dominant theoretical approach employed to intervene on physical activity has been social cognitive in nature (Rhodes & Nasuti, 2011) and typically includes applications of social cognitive/self-efficacy theory (Bandura, 1998), theory of reasoned action/planned behaviour (Ajzen, 1991), or the transtheoretical model of behaviour change (Prochaska & Velicer, 1997). Social cognitive theories applied to physical activity emphasize reasoned, deliberative, reflective processes such as attitudes, self-efficacy, and intentions. Commensurate with these theories,

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physical activity interventions have focused predominantly on techniques to educate about physical activity benefits, build perceived capability to perform physical activity, and self-regulate behavioural action (Chase, 2015; Conn, Hafdahl, & Mehr, 2011; Rhodes, Bredin, Janssen, Warburton, & Bauman, 2017). Meta-analyses of physical activity interventions using these approaches tend to show short-term behaviour changes in the small but meaningful range, particularly those that emphasize self-regulation strategies such as self-monitoring, feedback, and planning (d = 0.27; SD = 0.13 Rhodes et al., 2017). Thus, while intervention approaches based on traditional social cognitive models do show some effectiveness in physical activity promotion, there is room to expand upon different targets to change behaviour.

In line with this thinking, more recent innovations in the physical activity domain have attempted to incorporate constructs that reflect the non-conscious, automatic, reflexive processes that lead to action (Rebar et al., 2016). This approach is consistent with dual process frameworks that identify two types of routes to action: a more non-conscious route that involves minimal deliberation and is experienced as fast, efficient, low effort, and uncontrollable, and a more conscious route that requires deliberation of the goal-relevance of the action and its consequences and is experienced as slow, effortful, and controlled (Evans & Stanovich, 2013; Strack & Deutsch, 2004). Research adopting such dual process approaches have frequently reported direct effects of non-conscious constructs on physical activity (Conroy & Berry, 2017; Gardner, de Bruijn, & Lally, 2011; Rebar et al., 2016). Although there are several different constructs that follow the non-conscious route of influence such as implicit attitudes, affective responses, and automatic self-schema, one of the most compelling, and controversial, concepts in the physical activity domain is habit because the theorized automatic and unintentional features of habit seemingly contradicts the complexity and effort required for this behaviour. In this chapter, we overview current evidence and conception of physical activity habit formation with a focus on its controversial nature among physical activity scientists and how specific streams of research may advance our knowledge from earlier work.

Overview of the Habit Concept

Habit is the process by which behaviour is influenced by well-learned cue–behaviour associations, as is depicted in the top half of Fig. 6.1 (Gardner, 2015; Rebar, 2017; Wood & Rünger, 2016). About half of people's daily behaviour is performed at the same time of day and in the same context (Epstein, 1979; Wood, 2017). Over time, as behaviour is reliably performed in the same context, people can learn to associate certain cues (e.g., time of day, part of routine, locations, routine events) with the initiation of the behaviour. These associations are stored in procedural memory and influence behaviour through elicitation of behavioural approach tendencies. Upon experience of the cue, the approach tendency is triggered and results in an urge to engage in the habitual behaviour. Whether the urge translates into

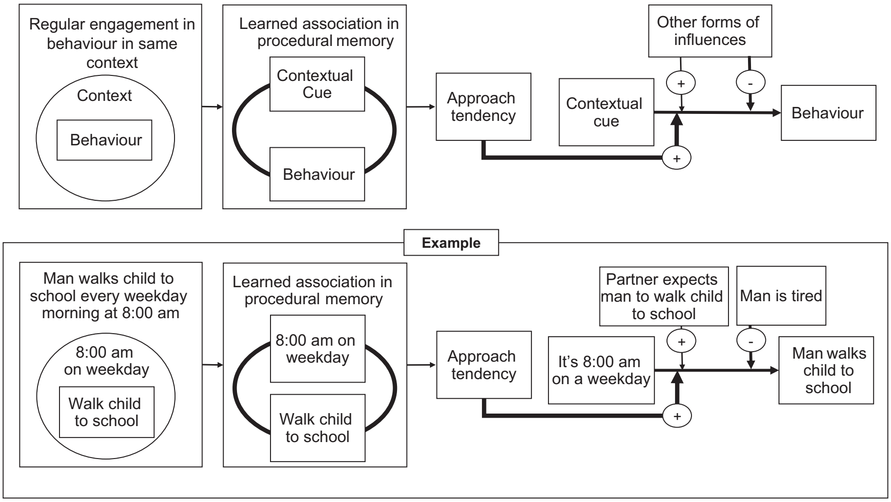

Fig. 6.1 Schematic of the process (top) and an example (bottom) of habit influencing behaviour through learned cue–behaviour associations manifesting as approach behavioural tendencies

behavioural engagement or not depends on the strength of the learned cue–behaviour association and the strength of any opposing or supporting motivational influences (e.g., feelings of fatigue, opposing motivation or self-regulation). Because the urge to act is automatically triggered by the cue, there is less need to deliberate about why and how to engage in habitual behaviours. Habits are the mind's 'short cuts'—allowing us to successfully engage in our regular daily life behaviours while reserving our reasoning and executive functioning capacities for other thoughts and actions.

An example of a physical activity habit is shown in the bottom half of Fig. 6.1. A man walks his child to school every weekday morning at 8:00 a.m. and, over time, develops a learned association between the cue of it being *8:00 a.m. on a weekday* and the physical activity behaviour of *walking the child to school*. This learned cue–behaviour association translates into an approach tendency such that when the man encounters the cue of it being *8:00 a.m. on a weekday*, he feels an urge to enact the behaviour of *walking the child to school*. This approach tendency elicits an influence on behaviour. Even though the man also experiences a countering influence from being tired, the approach tendency from the habit as well as that of the partner's expectation lead to the enactment of the habitual behaviour, and the man walks the child to school.

Importantly, this perspective of habit as an automatic process of behavioural influence is a relatively recent conceptual advancement. Up until about 15 years ago, habit was conceptualized as a reflection of frequency of past behaviour, whereas now habit is considered as a psychological determinant of behaviour (Gardner, 2012; Verplanken, 2006; Wood & Rünger, 2016). This evolution in thinking was based on the reasoning that defining habit as frequency does little to provide insight into *why* the behaviour is performed. Just like future behaviour is predicted by an assortment of motivational influences, so too is past behaviour. When past behaviour is applied as a predictor of future behaviour, it encompasses any and all reliable predictors of behaviour and not just habit (Ajzen, 2002). Thus past behaviour does little to help describe the psychological processes behind engagement in behaviour or inform behaviour change interventions.

The transition from viewing habit as a description of frequent physical activity behaviour to that of an automatic psychological influence on physical activity behaviour has been slow and tenuous. The literature remains fraught with colloquial use of the term ‘habit’ as a synonym of ‘behaviour’ which makes summative work exasperating (not that we’re complaining…). Additionally, the study of habit superseded most applications of dual process theories in the study of health behaviours such as physical activity. So, early physical activity habit research elicited scrutiny on theoretical terms in that it required shifting from traditional theoretical perspectives of physical activity motivation as well as scrutiny of the empirical validity of the measurement and study of physical activity habit.

Habit and Physical Activity Research

Although there was earlier theorizing about habit as an essential determinant of physical activity (e.g., Triandis, 1977), regular study of physical activity habit was not prevalent until the twenty-first century. In 2008, Verplanken and Melkevik adapted the Self-Report Habit Index (SRHI) for exercise behaviour (Verplanken & Melkevik, 2008). Their initial studies demonstrated that the measure was reliable, stable over time, and—most importantly—that habit was distinct from exercise behaviour frequency, intentions, and perceived behavioural control. Not long after the initial self-report measure of physical activity habit was introduced, Gardner, Abraham, Lally, and De Bruijn (2012) validated their abbreviation of the Self-Report Habit Index—the Self-Report Behavioural Automaticity Index (SRBAI)—allowing for isolated measurement of the automaticity aspect of habit. Likely, a result of the validation of these measures, the study of habit within physical activity research has grown exponentially in the last 15 years.

Two systematic reviews have aggregated the evidence of physical activity and habit (Gardner et al., 2011; Rebar et al., 2016). The latter review found that of the 37 studies on physical activity habit, 70% showed significant, positive associations between self-reported habit and behaviour. Both reviews concluded that the strength of the association between habit and physical activity behaviour was typically found to be moderate/strong ($r = 0.43$, Gardner et al., 2011; $r = 0.32$, Rebar et al., 2016). Of the 15 studies which simultaneously tested habit with other motivational influences on behaviour (e.g., intentions, perceived behavioural control, attitudes), the positive association between habit and physical activity behaviour remained positive and statistically significant in all but two studies (Rebar et al., 2016). Given that most of the traditionally applied models of exercise motivation set intentions as the necessary and sufficient precursor to behaviour (Rhodes, 2017; Rhodes & Rebar, 2017), these findings that habit explains variability in physical activity behaviour beyond intentions is noteworthy for the field. In summary, current observational research supports a medium-sized relationship between habit and physical activity that remains salient after controlling for social cognitive explanations of the behaviour.

Advancing Habit Research in Physical Activity

Conceptions of Habit for Physical Activity

While observational evidence supports the potential role of habit in physical activity, there have been strong positions that it makes little sense for such a complex behaviour (e.g., Maddux, 1997). Indeed, in our own experiences, reactions to presentations of physical activity habit research are divergent and dependent on the audience. Explanations and definitions of habit do not seem to be the source of this controversy. Instead, the disagreement over habit seems to be based on the nature of physical activity itself and whether the behaviour can be habitual. Physical activity is different from other health behaviours, and the traditional theories that are applied to understand physical activity from other domains may not take these aspects into account adequately (Rhodes & Nigg, 2011).

When considering whether exercise can be habitual, there are a few unique characteristics of the physical activity experience that require consideration. First, the behaviour takes a lot of time to enact. Current public health recommendations for physical activity suggest that accumulation of 10 min bouts may be sufficient for attaining the 150 min per week adult guidelines (World Health Organization, 2008), but the physical activity experience also often includes time-consuming preparation (transport to a location, changing clothes) and transition actions (showering, changing) (Kaushal, Rhodes, Meldrum, & Spence, 2017). Taken together, lack of time for the physical activity experience is considered its most common barrier (Bauman et al., 2012) and it would not be unreasonable to suggest that it takes anywhere from 30 to 120 min to perform a single bout. This is an immediate red flag for early habit explanations of physical activity, given the automaticity assumption that people will have minimal awareness and control of habitual behaviours (Bargh, 1992). In fact, we would be very concerned if exercisers could not account for or control where they have been or what happened during a 30+ min period several times per week! Memory recall issues are often considered a limitation of self-reported physical activity (Prince et al., 2008), but loss of awareness is an entirely different matter.

Second, physical activity takes the body out of a resting state and activates affective and physiological responses (Ekkekakis, Hall, & Petruzzello, 2008) that are contrary to the evolutionary aims of energy conservation (Lee, Emerson, & Williams, 2016). As the intensity of the physical activity increases (particularly above the ventilatory threshold), the potency of discomfort increases. This experience also runs counter to the automaticity assumptions of habit. The probability of someone having intense experiences of affective and physiological activation from a stimulus like vigorous intensity physical activity and simultaneously not having a conscious experience is low.

Third, enactment of physical activity is not a simple behaviour like some other health behaviours (e.g., taking prescribed medication, health screening) but actually requires a complex series of behaviours from preparation and initiation to the sequencing behaviours during enactment. Habit may explain why someone turns off the light switch as they leave a room, but the sequencing for physical activity is extremely complex (Hagger, Rebar, Mullan, Lipp, & Chatzisarantis, 2015; Maddux, 1997). Thus, a habit explanation of external cues regulating the entire complex chain of behavioural sequences involved in physical activity behaviour seems improbable.

Taken together, there are very sensible arguments to refute a habit explanation for physical activity. It should come as no surprise that the field of exercise psychology is dominated by motivational theories of conscious deliberative constructs such as behavioural regulation, attitudes, intentions, and self-efficacy (Biddle & Nigg, 2000; Rebar & Rhodes, in press). Still, there are some characteristics of physical activity that support the possibility of habit formation. Regular physical activity is a repeated behaviour. This is considered an essential aspect of habits and habit formation (Wood & Rünger, 2016). Physical activity also has a high likelihood of being reliably performed in the same context as part of a routine. Routine itself is not habit, but it does increase the likelihood of exposure to similar contextual cues, which is a predisposing factor in habit formation (Gardner, 2015). Finally, habit is a consistent predictor of physical activity, even after past behaviour and deliberative constructs such as intentions are used as controls in the models (Rebar et al., 2016).

Some advances in the conception of habit within physical activity science may help bridge criticisms and support that physical activity can be habitual. Specifically, as previously noted, it is important to acknowledge that physical activity is not a simple behaviour but a description of a variety of complex behaviours made up of many sub-actions. Thus, while the argument that physical activity is too complicated to be habitual has been used to suggest that habit cannot account for physical activity, what it actually refutes is the notion of a bifurcated habit explanation for physical activity in its entirety. Habit and deliberative motivation may be an all or nothing phenomena (i.e. one type of influence can only account for behaviour at one point in time), but this does not need to hold true across the 30+ min of physical activity behaviour. Gardner, Phillips, and Judah (2016) outline this process with an action-phase perspective based on the theorizing of Cooper and Shallice (2006). They suggest that complex behaviours like physical activity portray an action hierarchically, where actions are composed of lower-level sub-actions and give the example of going for a run:

For example, 'going for a run' may be decomposed into sub-actions including 'putting on sneakers' and 'leaving the house', each of which can be decomposed further (e.g., 'putting on left sneaker', 'tying laces', 'putting on right sneaker'). (p. 615).

This approach to understanding physical activity allows for various behavioural sequences to begin to chunk into automatically regulated actions (Graybiel, 2008). For example, a new exerciser who begins a running program will first need to deliberate each aspect of this physical activity behaviour from preparation decisions (choice of time, clothing, etc.) to enactment aspects (route taken, running speed, pace, and style) (see Fig. 6.2a). Over time, several of these aspects may become automated through skill acquisition of simple sub-actions (running style) or through habit formation of the more higher order choices and actions (traveling to facility, deciding what activities to do; See Fig. 6.2b). Over time, as people form memories of associating the end of the previous sub-action with the initiation of the next, each sub-action will no longer require deliberation, but rather will be automatically cued into action from the approach tendency triggered by the context.

Taking this approach to understanding physical activity habit formation requires an identification of the critical aspects of the behavioural sequence. An assessment of every possible sub-action would be unwieldy and thus ineffective. Building off the initial work of Verplanken and Melkevik (2008), Gardner and colleagues (Gardner et al., 2016; Phillips & Gardner, 2016) have suggested that an initiation/selection phase (decision to act over other potential stimuli) and an execution phase (the subsequent sequenced actions) could be a useful way to conceptualize the complex physical activity sequence (see Fig. 6.2). In a similar fashion, Kaushal, Rhodes, Spence, and Meldrum (2017) suggested that a preparation phase (pre-physical activity behaviours and initiation) and an execution phase may be a useful approach to understanding physical activity habit. While both the instigation and execution phases could become habitual, as noted previously, all sets of researchers have argued that the instigation phase is likely more important for understanding regular physical activity because it denotes the antecedent selection process. By contrast, the execution phase could explain physical activity duration or effort exertion but would not seemingly explain why physical activity would be repeatedly selected

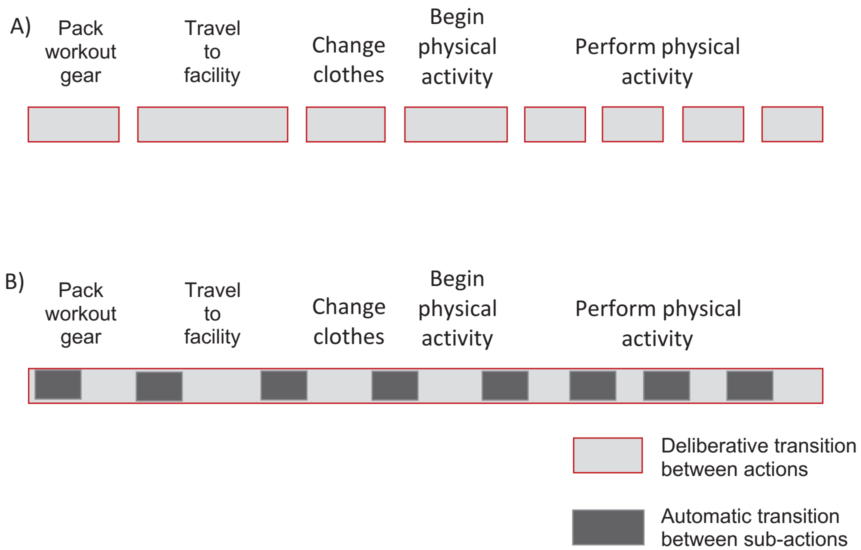

Fig. 6.2 Proposed transition between consciously deliberated physical activity and habit-facilitated physical activity

and initiated (Gardner et al., 2016). Specifically, we put forward that instigation habits for physical activity likely serve a dual role: they serve to drive an impulse/urge to initiate regular engagement in physical activity as per the noted role of habit outlined in Gardner (2015) and block the selection of alternative actions in reflective decision making (Verplanken, Walker, Davis, & Jurasek, 2008; Walker, Thomas, & Verplanken, 2015), similar to the process outlined by Markus (1977) in schema theory. In essence, instigation habits create an energy to perform physical activity and a tunnel vision toward that behaviour instead of alternative actions.

In initial support of this theorizing, several studies have now shown that the instigation phase is the dominant predictor of frequency of physical activity participation (Gardner et al., 2016; Kaushal, Rhodes, Meldrum, et al., 2017; Phillips & Gardner, 2016). Furthermore, instigation phase habit formation seems to be what is represented in generalized measures of habit such as the SRHI (Gardner et al., 2016), so the results are concordant with past evidence but help elucidate the more exact process of habit in physical activity. This finding also overcomes some of the common criticisms for a habit explanation of physical activity. First, the instigation phase is inherently much shorter than the execution phase—arguably very short as a moment in time, in which case it rebuffs the argument that the long duration of physical activity makes it unlikely to be driven by automatic processes such as habit. Second, the instigation phase is not during the process of physical exertion whereby the affective and physiological activation response to physical activity occurs. This alleviates the contrasting viewpoints between automaticity and aversive affect in physical activity as intensity increases. Overall, fine-tuning of the instigation habit phase is still needed but the distinction of these phases has contributed to a richer understanding of how the habit concept may operate in physical activity.

The Relationship Between Motivation and Habit in Physical Activity

One of the defining features of the automaticity of habit is the lack of necessary awareness of the behavioural action (Gardner, 2015; Oullette & Wood, 1998; Verplanken & Aarts, 1999; Wood & Rünger, 2016). Furthermore, Wood and Rünger (2016) consider the desensitization of outcomes and experiences as a critical aspect of what separates a habit from other implicit or non-conscious concepts and behaviour. Consequently, deliberative motivation and habit are sometimes represented as mutually exclusive in their function on behaviour. This provides an immediate challenge to disentangle when understanding health behaviours such as physical activity, because there is considerably strong evidence to support the role of deliberative motivation and self-regulation. For example, intention to engage in physical activity is associated with behaviour to a large effect (McEachan, Conner, Taylor, & Lawton, 2011) and self-regulation techniques such as goal setting (McEwan et al., 2016) and self-monitoring (Michie, Abraham, Whittington, McAteer, & Gupta, 2009) are among the most reliable components of physical activity change efforts.

As a result, several models of how goals, deliberative motivation and habits may relate to each other have been postulated (Fleig et al., 2013; Oullette & Wood, 1998; Rhodes, 2017; Verplanken & Aarts, 1999; Wood & Rünger, 2016) and the blend of these factors represents the heart of dual process approaches to understanding behaviour (Evans & Stanovich, 2013; Strack & Deutsch, 2004). There are minor deviations in these models, but most suggest that behaviour change originates with motivation and subsequent goal-driven behaviour. Over time, if the behaviour is performed in a context with similar cues, the supposition is that a habit elicits a cue-to-action that replaces the deliberative and goal-based determination of the behaviour. From a dual process model perspective, this habit response is considered the more efficient default, as attention and effort can be freed to other aspects requiring deliberative attention (Wood & Rünger, 2016). Only noteworthy changes to the system (e.g., removed cues, changes to mental state) will return the focus to the more conscious and deliberative system.

Tests of this proposed relationship between habit and deliberative motivation—typically measured with the intention construct—in physical activity have been mixed. Recent overviews (Gardner, 2015; Gardner et al., 2011; Rebar et al., 2016) have found about half of the studies do support a negative interaction between intention and habit on physical activity, but several of these tests have shown a positive interaction (Orbell & Verplanken, 2015). The confounded results are almost certainly due to the conceptual arguments about physical activity noted above. While habit and deliberative motivation may be mutually exclusive influences at any particular point in time, the complex sequence of physical activity behaviours allows for aspects of physical activity behaviour to be both deliberative and habitual. The oversimplified all-or-nothing concept of habitual physical activity is not an appropriate approach to investigating its relationship with deliberative motivation.

The relationship between physical activity and intention has also been given insufficient attention in this three-way interaction with habit. Intention to perform regular physical activity has an asymmetrical relationship with subsequent behaviour (Rhodes & de Bruijn, 2013a). Specifically, participants inhabit three of the four possible quadrants of this relationship: non-intenders who are subsequently inactive, intenders who are subsequently inactive, and intenders who are subsequently active. There are very few people (often <2%) who do not intend to engage in physical activity but are subsequently active (Rhodes & de Bruijn, 2013a). It is important to pause and reflect on this because it has serious implications for habit theory when applied to physical activity. The result refutes the concept that those with habits are acting without intention because almost no one is engaging in unintended physical activity. Indeed, given that habit is positively correlated with intention, the results are likely due to a statistical artifact in forcing asymmetrical relations to fit onto a linear regression model. The effect is likely from the restricted range in intention-behaviour variability in the high habit quadrants (i.e. no range in low intention/low behaviour or low intention high behaviour) compared to more range in the intention–behaviour relationship in the low habit quadrants (because those with low habits can be low intenders/low behaviour, high intenders/high behaviour, and high intenders/low behaviour). This issue was pointed out by

Rhodes, de Bruijn, and Matheson (2010) in their tests of the habit, intention, and physical activity relationship using regression, compared to a 2 × 2 × 2 contingency analysis of the constructs. What they found, and have subsequently replicated several times (see Rhodes & de Bruijn, 2013b), is that high habit is a predictor of action control (i.e. the translation of intentions into behaviour) after the confounding empty quadrant (low intention, high behaviour) is eliminated. One other reason why intention and habit are sometimes positively correlated may stem from self-perception (Wood & Rünger, 2016), where participants, when asked to express an intention, use one's habit as the salient piece of information to build on.

Taken together, it seems an opportune time to advance conceptions of deliberative motivation and habit considering the changing conceptions about physical activity and habit noted in the prior section. One way to do this may be to include the recent call for re-conceptualization for the intention construct in physical activity science (Rhodes & Rebar, 2017), given that intention is often used as a key proxy for deliberative processes. Rhodes and Rebar (2017) have demonstrated that intention comprises two conceptually and functionally different constructs: (1) a mental aim or determination for a specific end state, highlighting a binary decision and (2) a process of deliberative planning and/or behavioural actions, highlighting a continuum of motivational intensity. They suggest that the term *decisional intention* should be used to denote a mental aim and *intention strength* should be used when conceiving of a continuum of motivational intensity.

The properties of physical activity noted previously (time costs, energy and affect costs, complexity of actions) make it clear that the behaviour involves some deliberative processing, and past research indicates that almost all people who are physically active had a premeditative intention. Thus, decisional intention seems to be a guiding determinant in physical activity (Rhodes, 2017). That said, habit formation of physical activity could still co-occur with decisional intention. This is akin to synchronous dual processes (Verplanken & Aarts, 1999), and allows goal-directed behaviour to be achieved without heavy reliance on self-regulation. By contrast, intention strength and habit would seemingly not be able to co-occur because the habit response is characterized by lowered motivational intensity. Decisional intention may act as a guiding direction to perform regular physical activity but how this aim is selected, initiated, and carried out could be through conscious determination (intention strength) or habit; most likely there's some influence from both. Daily diary studies of this process provide within-person examples of how the interplay between habit and intention strength may unfold (Rebar, Elavsky, Maher, Doerksen, & Conroy, 2014). Under circumstances of low intention strength, people act in line with their physical activity habits; by contrast, when intention strength is high, the habit response is more likely to be overridden by intentions. Future research involving decisional intention, intention strength and habit is needed to fully explore this possibility and the roles of these constructs across phases of behaviour such as instigation and execution.

Forming Physical Activity Habits

Habit formation is reliant on what Lally and Gardner (2011) referred to as *context-dependent repetition*, which simply means that, for a behaviour to become habitual, the behaviour must be reliably and frequently initiated in the same context (also see Gardner & Lally, Chap. 12 in this book). If the behaviour and context are not regularly experienced as a pair, the learned cue–behaviour association never has a chance to form in procedural memory (Wood, Quinn, & Kashy, 2002). However, over time as the habit forms, what may initially be experienced as quite a willful process can become less arduous. People describe habit formation as being difficult to do at first but over time becoming easier and like 'second nature' (Allom & Mullan, 2014; Lally, Wardle, & Gardner, 2011).

One of the major benefits of having habits is that it reduces the need for using self-control; however, quite ironically, literature on habit formation often suggests the process requires self-control (Judah, Gardner, & Aunger, 2013; Lally et al., 2011; Lally & Gardner, 2011). For example, Lally and Gardner (2011) advocate goal setting, self-monitoring, and planning as strategies for forming health-promoting habits. Indeed if the behaviour is goal-directed initially then, until habits form, enacting the behaviour in the same context will be reliant on self-control. Although missing one cue–behaviour pairing is not necessarily detrimental to habit formation (Lally, van Jaarsveld, Potts, & Wardle, 2009), multiple or many consecutive missed opportunities likely hinders habit formation processes (Armitage, 2005).

When taken on as a goal to be achieved with self-control, habit formation can feel like a count-down process. Based on this mentality, people typically want to know how long it takes for a habit to form because then they have a tangible date they can strive toward. Studies that tracked health behaviour habit formation over time show substantial between-person variability in the process, with one study suggesting that forming habits can take anywhere from 1 to 4 months (Lally et al., 2009) and a study tracking gym-based exercise habit formation found the process tended to take roughly between 6 weeks and 2 months (Kaushal & Rhodes, 2015). Given that the research suggests the timing of habit formation for health behaviours is unpredictable and likely quite slow, reliance on self-control until habits form would seem crucial, yet merely sticking to a program long enough in the hopes one will form a habit may be too simplistic.

It may be that habit formation does not need to rely on self-control though. It could be argued that most habits are actually the result of incidental, rather than goal-directed, cue–behaviour pairings. The people most likely to be regularly active are not those who most value the benefits of it but rather it is those who intrinsically enjoy it (Rhodes, Fiala, & Conner, 2009; Teixeira, Carraça, Markland, Silva, & Ryan, 2012). Indeed, the few studies that have been conducted on habit formation of physical activity indicate that intrinsic motivation plays an instrumental role in the process. In their study tracking new gym members' habit formation processes, Kaushal and Rhodes (2015) showed that exercise habits were more likely to be formed if people found the exercise experiences to be pleasant. Radel, Pelletier, Pjevac, and Cheval (2017) showed that habit formation of a variety of health behaviours including physical activity was partially mediated by self-determined motivation, in that people who found the behaviour more intrinsically rewarding were more likely to form stronger habits. For people who found physical activity intrinsically rewarding, frequent physical activity behaviour was more likely to be habitual than for people who did not find it as intrinsically rewarding. It seems likely that physical activity habit formation will be most achievable if the context-dependent repetition of physical activity is intrinsically rewarding.

Although there have been a few studies which targeted habit formation of physical activity as part of weight loss interventions (Beeken et al., 2005; Carels et al., 2011; Lally, Chipperfield, & Wardle, 2008), the field still lacks many rigorous trials of habit formation interventions for physical activity specifically. In one of the first of these trials, however, Kaushal, Rhodes, Spence, et al. (2017) showed that an 8-week intervention focused on planning of contextual repetition of behaviour paired with cue resulted in more objectively measured and self-reported moderate-vigorous physical activity than a control group provided with education material. The next major step is to continue this line of research on habit formation strategies as well as system-level approaches that make physical activity the default, easiest, salient, and most pleasant option (Sheeran, Gollwitzer, & Bargh, 2013). Although helping people to form physical activity (instigation) habits will not make performing the activity less physically strenuous or difficult, it could be a key catalyst for reducing physical inactivity rates.

Future Directions and Conclusions

While the conception of habitual physical activity has improved in clarity since early research and initial intervention studies are promising, this is still an area in its infancy. The reliance on self-reported habit is likely the largest limitation to this field of inquiry (Hagger et al., 2015), but there are also several interesting streams of future research needed in physical activity science. For example, as the field moves beyond the basic questions of whether there is a role for habit in physical activity and the basic interplay between deliberative and habitual processes, an important series of questions involve individual and environmental differences in physical activity habit formation.

There are likely several individual difference factors that could potentially mitigate the formation of a habit. As mentioned in the prior section, those people who have low affective judgements and/or affective responses from physical activity are less likely to achieve the automaticity component underlying habitual physical activity (de Bruijn, Gardner, van Osch, & Sniehotta, 2014; Kaushal & Rhodes, 2015), and this is likely due to anticipated or experienced displeasure that forces one to deliberate on the experience. Whether affect can be intervened upon to improve habit formation would seem a useful topic of future research. Given the repetitive aspects of physical activity needed to form a habit, those individuals with a high need for variety (Sylvester et al., 2016) may also have difficulty in habit formation.

This need for variety may not affect initiation/preparation habit as much as execution habit (Kaushal, Rhodes, Meldrum, et al., 2017), but the extent of need for variety on habit formation warrants future research.

There are also external lifestyle factors that could mitigate physical activity habit formation. People with changing work schedules, such as shift work, often have difficulty adhering to physical activity (Kirk & Rhodes, 2011), and one reason may be that the lack of routine reduces the opportunity for habit formation of physical activity because one is not exposed to consistent contextual cues. Similarly, people with an erratic or demanding and changing home life circumstances (e.g., early parenthood, caring for others who are ill or unstable, bereavement, unemployment) often have difficulty with maintaining regular physical activity (Allender, Hutchinson, & Foster, 2008). These changing demands, like shift work, may reduce the consistency of physical activity contexts and practices and thus lower the opportunity to form cue–behaviour connections through repeated experience. Future research on whether this conjecture is accurate would be helpful, and may set the stage for important intervention research.

While research thus far has focussed exclusively on physical activity habit formation, there is a growing focus on viewing human movement on an interactive continuum that also includes sedentary behaviour and even sleep (Ekelund et al., 2016; Tremblay et al., 2016). Thus, the role of sedentary behaviour habits and their potential negative impact on habitual physical activity would seem a prudent area for future research (Marchant, Chevance, & Boiché, 2016). This mimics the literature that has explored the cross-relations of unhealthy eating and screen time habits with healthy eating behaviour (Naughton, McCarthy, & McCarthy, 2015; Verplanken & Faes, 1999) and would also complement past research on the deliberative aspects of conflicting and facilitative physical activity goals (Rhodes, Quinlan, & Mistry, 2016).

Another potentially interesting area of research is to explore who may benefit most from the development of a physical activity habit. Currently, our understanding of habitual physical activity is over-represented by university students (Rebar et al., 2016). It would be interesting to explore habitual physical activity formation with clinical populations, vulnerable populations, or other groups at risk for inactivity who may have the most to gain from increased regular physical activity. Overall, we would expect that those who may benefit the most from habit interventions are people who are not intrinsically motivated by physical activity but seek its health benefits. This is a paradox because those who intrinsically value physical activity are less likely to be concerned about forming a habit (Maddux, 1997), but seem more likely to have one regardless of this desire (Radel et al., 2017).

In conclusion, in this chapter we overviewed the current evidence and conception of physical activity habit formation. We highlighted that physical activity scientists have often been skeptical of habitual physical activity based on several unique aspects of the behaviour that highlight its deliberative and regulatory aspects. Despite this reticence among many scientists, observational evidence is clearly supportive of a relationship between self-reported habit and physical activity, even after controlling for motivational and self-regulatory processes. We suggested that the more recent separation between the phases (initiation, execution) of physical activity has helped delineate where habit may determine physical activity overcome its past controversial nature among physical activity scientists. Furthermore, separations among different concepts of intention (decision, strength) may help improve our understanding of how deliberative motivation and habituation interact and co-determine behaviour. While intervention research of habitual physical activity is scarce, early results suggest attending to specific conditions (contextual repetitions, cues, scripts) can expedite and improve the likelihood of habit formation.

Habit Research in Action
Can exercise be habitual?
Some people have a hard timing thinking about exercise as possibly being habitual. Unlike other behaviours studied in habit research, exercise takes a lot of time to enact, involves intense experiences of affective and physiological activation, and is complex—involving a sequencing of a lot of small, simple behaviours. How could this all be done automatically with little awareness or intent? There have been recent advancements distinguishing between habit of the *preparation* and *instigation* of the behaviour (e.g., 'I am going to exercise now') and the subsequent *execution* (e.g., complete exercises), which help clarify what it means for exercise to be habitual (Gardner et al., 2016; Kaushal, Rhodes, Meldrum, et al., 2017; Phillips & Gardner, 2016). Typically, when considering exercise habits and its impact of frequency of future exercise behaviour, researchers are interested in capturing habitual instigation—the degree to which the initial decision to start the exercise behaviour process is habitual. Precise terminology is important in self-reported measures of habit so that respondents clearly understand what specific aspect of the exercise behaviour experience you are inquiring about (e.g., 'The decision to start exercising…').

Even if only accounting for the simple, initial decisional action of exercise behaviour, it is unlikely that habit influences exercise entirely without motivation. It is oversimplified to think of exercise as either intentional or habitual. Taken into account with recent distinctions in the conceptualizations of decisional intention (i.e. directional aim to engage in behaviour or not) versus intention strength (i.e. the degree of commitment to engaging in the behaviour or not) (Rhodes & Rebar, 2017), the refinement of exercise habit as separate instigation and execution processes helps clarify how habit and self-regulatory motivation may interact to influence behaviour. While habit and deliberative motivation may be mutually exclusive influences at any particular point in time, the complex sequence of physical activity behaviours allows for aspects of physical activity behaviour to be both intentional and habitual.

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References

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.

Allender, S., Hutchinson, L., & Foster, C. (2008). Life-change events and participation in physical activity: A systematic review. *Health Promotion International, 23*, 160–172.

Allom, V., & Mullan, B. (2014). Maintaining healthy eating behaviour: Experiences and perceptions of young adults. *Nutrition & Food Science, 44*, 156–167.

Armitage, C. J. (2005). Can the theory of planned behavior predict the maintenance of physical activity? *Health Psychology, 24*, 235–245.

Bandura, A. (1998). Health promotion from the perspective of social cognitive theory. *Psychology and Health, 13*, 623–649.

Bargh, J. A. (1992). The ecology of automaticity: Toward establishing the conditions needed to produce automatic processing effects. *American Journal of Psychology, 105*, 181–199.

Bauman, A., Reis, R. S., Sallis, J. F., Wells, J. C., Loos, R. J. F., Martin, B. W., et al. (2012). Correlates of physical activity: Why are some people physically active and others not? *Lancet, 380*, 258–271.

Beeken, R. J., Leurent, B., Vickerstaff, V., Wilson, R., Croker, H., Morris, S., et al. (2005). A brief intervention for weight control based on habit-formation theory delivered through primary care: Results from a randomised controlled trial. *International Journal of Obesity, 41*, 246–254.

Biddle, S. J. H., & Nigg, C. R. (2000). Theories of exercise behavior. *International Journal of Sport Psychology, 31*, 290–304.

Carels, R. A., Young, K. M., Koball, A., Gumble, A., Darby, L. A., Wagner Oehlhof, M., et al. (2011). Transforming your life: An environmental modification approach to weight loss. *Journal of Health Psychology, 16*, 430–438.

Chase, J. A. D. (2015). Interventions to increase physical activity among older adults: A meta-analysis. *The Gerontologist, 55*, 706–718.

Colley, R. C., Garriguet, D., Janssen, I., Craig, C. L., Clarke, J., & Tremblay, M. S. (2011). Physical activity of Canadian adults: Accelerometer results from the 2007 to 2009 Canadian health measures survey, health reports. *Statistics Canada, 22*, 1–8.

Conn, V. S., Hafdahl, A. R., & Mehr, D. R. (2011). Interventions to increase physical activity among healthy adults: Meta-analysis of outcomes. *American Journal of Public Health, 101*, 751–758.

Conroy, D. E., & Berry, T. R. (2017). Automatic affective evaluations of physical activity. *Exercise & Sport Sciences Reviews, 45*, 230–237.

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

de Bruijn, G. J., Gardner, B., van Osch, L., & Sniehotta, F. F. (2014). Predicting automaticity in exercise behaviour: The role of perceived behavioural control, affect, intention, action planning, and behaviour. *International Journal of Behavioral Medicine, 21*, 767–774.

Ekelund, U., Steene-Johannessen, J., Brown, W. J., Fagerland, M. W., Owen, N., Powell, K. E., et al. (2016). Does physical activity attenuate, or even eliminate, the detrimental association of sitting time with mortality? A harmonised meta-analysis of data from more than 1 million men and women. *Lancet, 388*, 1302–1310.

Ekkekakis, P., Hall, E. E., & Petruzzello, S. J. (2008). The relationship between exercise intensity and affective responses demystified: To crack the 40 year-old nut, replace the 40-year-old nutcracker! *Annals of Behavioral Medicine, 35*, 136–149.

Epstein, S. (1979). The stability of behavior: I. On predicting most of the people much of the time. *Journal of Personality and Social Psychology, 37*, 1097–1126.

Evans, J. S. B. T., & Stanovich, K. E. (2013). Dual-process theories of higher cognition. *Perspectives on Psychological Science, 8*(3), 223–241. https://doi.org/10.1177/1745691612460685

Fleig, L., Pomp, S., Parschau, L., Barz, M., Lange, D., Schwarzer, R., et al. (2013). From intentions via planning and behavior to physical exercise habits. *Psychology of Sport & Exercise, 14*, 632–649.

Gardner, B. (2012). Habit as automaticity, not frequency. *European Health Psychologist, 14*, 32–36.

Gardner, B. (2015). A review and analysis of the use of 'habit' in understanding, predicting and influencing health-related behaviour. *Health Psychology Review, 9*, 277–295. https://doi.org/10.1080/17437199.2013.876238

Gardner, B., Abraham, C., Lally, P., & De Bruijn, G. J. (2012). Towards parsimony in habit measurement: Testing the convergent and predictive validity of an automaticity subscale of the self-report habit index. *International Journal of Behavioral Nutrition and Physical Activity, 9*, 102.

Gardner, B., de Bruijn, G. J., & Lally, P. (2011). A systematic review and meta-analysis of applications of the self-report habit index to nutrition and physical activity behaviors. *Annals of Behavioral Medicine, 42*, 174–187.

Gardner, B., Phillips, L. A., & Judah, G. (2016). Habitual instigation and habitual execution: Definition, measurement, and effects on behaviour frequency. *British Journal of Health Psychology, 21*, 613–630.

Graybiel, A. M. (2008). Habits, rituals, and the evaluative brain. *Annual Review of Neuroscience, 31*, 359–387.

Hagger, M. S., Rebar, A., Mullan, B., Lipp, O. V., & Chatzisarantis, N. L. D. (2015). The subjective experience of habit captured by self-report indexes may lead to inaccuracies in the measurement of habitual action. *Health Psychology Review, 9*, 296–302.

Hallal, P. C., Andersen, L. B., Bull, F. C., Guthold, R., Haskell, W., Ekelund, U., et al. (2012). Global physical activity levels: Surveillance progress, pitfalls, and prospects. *The Lancet, 380*, 247–257.

Judah, G., Gardner, B., & Aunger, R. (2013). An exploratory study of flossing habit formation. *British Journal of Health Psychology, 18*, 338–353.

Kaushal, N., & Rhodes, R. E. (2015). Exercise habit in new gym members: A longitudinal study. *Journal of Behavioral Medicine, 38*, 652–663.

Kaushal, N., Rhodes, R. E., Meldrum, J., & Spence, J. C. (2017). The role of habit in different phases of exercise. *British Journal of Health Psychology, 22*, 429–448.

Kaushal, N., Rhodes, R. E., Spence, J., & Meldrum, J. (2017). Increasing physical activity through principles of habit formation in new gym members: A randomized-controlled trial. *Annals of Behavioral Medicine, 51*, 578–586.

Kirk, M., & Rhodes, R. E. (2011). Occupation correlates of adults' participation in leisure-time physical activity: A systematic review. *American Journal of Preventive Medicine, 40*, 476–485.

Lally, P., Chipperfield, A., & Wardle, J. (2008). Healthy habits: Efficacy of simple advice on weight control based on a habit-formation model. *International Journal of Obesity, 32*, 700–707.

Lally, P., & Gardner, B. (2011). Promoting habit formation. *Health Psychology Review, 7*, 1–22.

Lally, P., van Jaarsveld, C. H. M., Potts, H. W. W., & Wardle, J. (2009). How are habits formed: Modelling habit formation in the real world. *European Journal of Social Psychology, 40*, 998–1009.

Lally, P., Wardle, J., & Gardner, B. (2011). Experiences of habit formation: A qualitative study. *Psychology, Health and Medicine, 16*, 484–489.

Lee, H. H., Emerson, J. A., & Williams, D. M. (2016). The exercise-affect-adherence pathway: An evolutionary perspective. *Frontiers in Psychology, 7*, 1285.

Maddux, J. E. (1997). Habit, health, and happiness. *Journal of Sport and Exercise Psychology, 19*, 331–346.

Marchant, G., Chevance, G., & Boiché, J. (2016). Intention and automaticity toward physical and sedentary screen-based leisure activities in adolescents: A profile perspective, Journal of Sport and Health Science. https://doi.org/10.1016/j.jshs.2016.08.006

Markus, H. (1977). Self-schemata and processing information about the self. *Journal of Personality and Social Psychology, 35*, 63–78.

McEachan, R., Conner, M., Taylor, N. J., & Lawton, R. J. (2011). Prospective prediction of health-related behaviors with the theory of planned behavior: A meta-analysis. *Health Psychology Review, 5*, 97–144.

McEwan, D., Harden, S. M., Zumbo, B. D., Sylvester, B. D., Kaulius, M., Ruissen, G. R., et al. (2016). The effectiveness of multi-component goal setting interventions for changing physical activity behaviour: A systematic review and meta-analysis. *Health Psychology Review, 10*, 67–88.

Michie, S., Abraham, C., Whittington, C., McAteer, J., & Gupta, S. (2009). Effective techniques in healthy eating and physical activity interventions: A meta-regression. *Health Psychology, 28*, 690–701.

Naughton, P., McCarthy, M., & McCarthy, S. (2015). Acting to self-regulate unhealthy eating habits. An investigation into the effects of habit, hedonic hunger and self-regulation on sugar consumption from confectionery foods. *Food Quality & Preference, 46*, 173–183.

Orbell, S., & Verplanken, B. (2015). The strength of habit. *Health Psychology Review, 9*, 311–317.

Oullette, J. A., & Wood, W. (1998). Habit in every day life: The multiple processes by which past behavior predicts future behavior. *Psychological Bulletin, 124*, 54–74.

Phillips, L. A., & Gardner, B. (2016). Habitual exercise instigation (vs. execution) predicts healthy adults' exercise frequency. *Health Psychology, 35*, 69–77.

Prince, S. A., Adamo, K. B., Hamel, M. E., Hardt, J., Connor Gorber, S., & Tremblay, M. (2008). A comparison of direct versus self-report measures for assessing physical activity in adults: A systematic review. *International Journal of Behavioral Nutrition and Physical Activity, 5*, 56. https://doi.org/10.1186/1479-5868-1185-1156

Prochaska, J. O., & Velicer, W. F. (1997). The transtheoretical model of health behavior change. *American Journal of Health Promotion, 12*, 38–48.

Radel, R., Pelletier, L., Pjevac, D., & Cheval, B. (2017). The links between self-determined motivations and behavioral automaticity in a variety of real-life behaviors. *Motivation and Emotion, 41*, 443–454.

Rebar, A. (2017). Automatic regulation used in sport and exercise research. In O. Braddick (Ed.), *Oxford research encyclopedia of psychology*. New York: Oxford University Press.

Rebar, A., Dimmock, J. A., Jackson, B., Rhodes, R. E., Kates, A., Starling, J., et al. (2016). A systematic review of the effects of non-conscious regulatory processes in physical activity. *Health Psychology Review, 10*, 395–407.

Rebar, A., Elavsky, S., Maher, J. P., Doerksen, S. E., & Conroy, D. E. (2014). Habits predict physical activity on days when intentions are weak. *Journal of Sport & Exercise Psychology, 36*, 157–165.

Rebar, A., & Rhodes, R. E. (in press). Progression of motivation models in exercise science: Where we have been and where we are heading. In G. Tenenbaum, & R. C. Eklund (Eds.), *Handbook of Sport Psychology (4th Edition)*.

Rebar, A., Stanton, R., Geard, D., Short, C. E., Duncan, M., & Vandelanotte, C. (2015). A meta-meta-analysis of the effect of physical activity on depression and anxiety in non-clinical adult populations. *Health Psychology Review, 9*, 366.

Rhodes, R. E. (2017). The evolving understanding of physical activity behavior: A multi-process action control approach. In A. J. Elliot (Ed.), *Advances in motivation science* (pp. 171–205).

Rhodes, R. E., Bredin, S. S. D., Janssen, I., Warburton, D. E. R., & Bauman, A. (2017). Physical activity: Health impact, prevalence, correlates and interventions. *Psychology and Health, 32*, 942–975.

Rhodes, R. E., & de Bruijn, G. J. (2013a). How big is the physical activity intention-behaviour gap? A meta-analysis using the action control framework. *British Journal of Health Psychology, 18*, 296–309.

Rhodes, R. E., & de Bruijn, G. J. (2013b). What predicts intention-behavior discordance? A review of the action control framework. *Exercise and Sports Sciences Reviews, 41*(4), 201–207.

Rhodes, R. E., de Bruijn, G. J., & Matheson, D. H. (2010). Habit in the physical activity domain: Integration with intention temporal stability and action control. *Journal of Sport and Exercise Psychology, 32*(1), 84–98.

Rhodes, R. E., Fiala, B., & Conner, M. (2009). Affective judgments and physical activity: A review and meta-analysis. *Annals of Behavioral Medicine, 38*, 180–204.

Rhodes, R. E., & Nasuti, G. (2011). Trends and changes in research on the psychology of physical activity across 20 years: A quantitative analysis of 10 journals. *Preventive Medicine, 53*(1–2), 17–23.

Rhodes, R. E., & Nigg, C. R. (2011). Advancing physical activity theory: A review and future directions. *Exercise and Sports Sciences Reviews, 39*, 113–119.

Rhodes, R. E., Quinlan, A., & Mistry, C. (2016). Do other goals influence physical activity? A systematic review examining the relationship between other goals and physical activity behaviour. *Preventive Medicine, 91*, 306–317.

Rhodes, R. E., & Rebar, A. (2017). Conceptualizing and defining the intention construct for future physical activity research. *Exercise and Sports Sciences Reviews, 45*, 209–216.

Sheeran, P., Gollwitzer, P. M., & Bargh, J. A. (2013). Nonconscious processes and health. *Health Psychology, 32*, 460–473.

Strack, F., & Deutsch, R. (2004). Reflective and impulsive determinants of social behavior. *Personality and Social Psychology Review, 8*, 220–247.

Sylvester, B. D., Standage, M., McEwan, D., Wolf, S. A., Lubans, D. R., Eather, N., et al. (2016). Variety support and exercise adherence behavior: Experimental and mediating effects. *Journal of Behavioral Medicine, 39*, 214–224.

Teixeira, P. J., Carraça, E. V., Markland, D., Silva, M. N., & Ryan, R. M. (2012). Exercise, physical activity, and self-determination theory: A systematic review. *International Journal of Behavioral Nutrition and Physical Activity, 9*, 78.

Tremblay, M. S., Carson, V., Chaput, J.-P., Connor Gorber, S., Dinh, T., & Duggan, M. (2016). Canadian 24-hour movement guidelines for children and youth: An integration of physical activity, sedentary behaviour, and sleep. *Applied Physiology, Nutrition and Metabolism, 41*, S311–S327.

Triandis, H. C. (1977). *Interpersonal behavior*. Monterey, CA: Brooks/Cole.

Troiano, R. P., Berrigan, D., Dodd, K. W., Masse, L. C., Tilert, T., & McDowell, M. (2008). Physical activity in the United States measured by accelerometer. *Medicine and Science in Sports and Exercise, 40*, 181–188.

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

Verplanken, B., & Aarts, H. (1999). Habit, attitude, and planned behaviour: 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). New York: Wiley.

Verplanken, B., & Faes, S. (1999). Good intentions, bad habits, and effects of forming implementation intentions on healthy eating. *European Journal of Social Psychology, 29*, 591–604.

Verplanken, B., & Melkevik, O. (2008). Predicting habit: The case of physical exercise. *Psychology of Sport and Exercise, 9*, 15–26.

Verplanken, B., Walker, I., Davis, A., & Jurasek, M. (2008). Context change and travel mode choice: Combining the habit discontinuity and self-activation hypotheses. *Journal of Environmental Psychology, 28*, 121–127.

Walker, I., Thomas, G. O., & Verplanken, B. (2015). Old habits die hard: Travel habit formation and decay during an office relocation. *Environment and Behavior, 47*, 1089–1106.

Warburton, D. E. R., Charlesworth, S., Ivey, A., Nettlefold, L., & Bredin, S. S. D. (2010). A systematic review of the evidence for Canada's physical activity guidelines for adults. *International Journal of Behavioral Nutrition and Physical Activity, 7*, 39.

Wood, W. (2017). Habit in personality and social psychology. *Personality and Social Psychology Review, 21*, 389–403.

Wood, W., Quinn, J. M., & Kashy, D. A. (2002). Habits in everyday life: Thought, emotion, and action. *Journal of Personality and Social Psychology, 83*, 1281–1297.
Wood, W., & Rünger, D. (2016). Psychology of habit. *Annual Review of Psychology, 67*, 1–11.
World Health Organization. (2008). Physical inactivity: A global public health problem. Retrieved from http://www.who.int/dietphysicalactivity/factsheet_inactivity/en/index.html
World Health Organization. (2012). Recommended levels of physical activity for adults aged 18–64 years. Retrieved from http://www.who.int/dietphysicalactivity/factsheet_adults/en/index.html

Chapter 7
Technology Habits: Progress, Problems, and Prospects

Joseph B. Bayer and Robert LaRose

At the turn of the twentieth century, an early study on telegraphic habits appeared in *Psychological Review* (Bryan & Harter, 1899). This long-forgotten article demonstrated how mastery of the telegraph depended on a hierarchal set of habits. And in some ways, not all that much has changed. The habits associated with *QWERTY* keyboards replaced the core processes found among telegraphic operators in the twentieth century. Sure, the physical keys and symbols are different, the individual goals and manoeuvres are different, and the surrounding contexts and cultures are different. Yet the habits of grouping automatically selecting keys to represent letters, combining co-occurring letters into words, and words into phrases, endure.

So, what is the contribution of *technology* habit research then? This chapter reviews the history of research on technology habits in the fields of communication studies and information systems, while also reflecting on the role of emergent technologies for habit research at large. Along the way, we trace how issues of measurement and conceptualization both challenge and advance the identification of replicable factors that explain technology habit mechanisms, antecedents, and consequences. In doing so, we discuss how technology habits repeatedly appear *special*, and often addiction-like, by modulating core habitual processes. Responding to the above question, we suggest that studying technology habits helps to elucidate the assumptions, boundaries, and moderators of habitual behaviour more broadly.

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What Are *Tech* Habits?

One of the cyclical challenges in studying technology habits is the question of how to define them, as well as how to describe the set of qualifying behaviours. In the years since the first study of telegraph habits, researchers have directed attention to habits across a range of technological innovations. Do bicycle habits represent a technology habit? Probably not in the contemporary sense, but maybe they should: transportation modes such as stage coaches were synonymous with "communication" before the invention of the telegraph (DeLuca, 2011). Alternatively, bike-share app usage is likely to be seen as a technology habit today, exhibiting how "technology" focuses not only on the physical object itself but also on the ways in which it is applied. Nonetheless, from a more historical perspective, these innovations are no more technological, or even necessarily social, than old-fashioned bicycles.

Over the last two decades, a myriad of keywords have been applied to organize the everyday habits associated with emergent media, including Internet, electronic, device, gaming, virtual, online, interactive, mobile, digital, network, and information and communication technologies (ICT) habits (LaRose, 2010a; Limayem & Hirt, 2003). Increasingly, and owing perhaps to the convergence of traditional mass and interpersonal communication systems (Walther & Valkenburg, 2017), "technology" is used as a catchall term (e.g. Clements & Boyle, 2018; Kuss & Billieux, 2017). Of course, if we understand "technology" to be literally "the study of technique", then transportation mode, health, and exercise habits that are said to dominate habit research (Orbell & Verplanken, 2015) might also be termed technology habits. In spite of this caveat, we adopt the term "tech habits" here to avoid further fragmentation while reflecting on the state of research progress, with a special emphasis on everyday innovations examined in the fields of communication and information systems.

A Short History: Progress in Tech Habit Research

Even before the popularization of the Internet and the renaissance of habit research in social psychology in the 1990s, habits were a topic of interest in information systems (Limayem & Hirt, 2003) and communication studies (LaRose, 2010a, 2015). Within communication research, for instance, habit research can be traced to a single item in Rubin's (1984) "ritual gratifications" measure ("It's just a habit") that was a predictor of television use. However, the gratifications examined in such work are defined to be actively and consciously processed, so habits cannot be gratifications (LaRose, 2010a).

As scholarly attention turned from the television to the Internet, habits were found to be significant predictors of diverse patterns of online behaviour, including general Internet use, online shopping, downloading media files, social networking, and online news consumption. Similar to social psychology research that verified the explanatory power of habits within the Theory of Planned Behavior (TPB), habits were pitted against competing variables emphasizing reflective thought processes and explained more variance in Internet usage than consciously processed outcome expectations or gratifications alone (see LaRose, 2010a). Although most of these studies relied on correlational designs, some experimental work has offered evidence of a causal relationship between habits and tech usage (Tokunaga, 2013).

Along a similar timeline, addiction arose as a rival explanation for frequent use of online tech. However, many addiction studies sampled normal populations, leading to separate (but clearly overlapping) lines of inquiry on tech habits. In response, LaRose (2010a, 2010b) proposed that so-called addictive uses among normal users were the result of deficient self-regulation. The deficient self-regulation model of media habits received support in a meta-analysis against a rival model of "problematic" Internet use (Tokunaga & Rains, 2010) and remains a viable explanation (Tokunaga, 2017). Despite the potential misnomer, tech addictions can also be interpreted through habitual neural mechanisms (Smith & Graybiel, 2016), and thereby aid in our understanding of (negative) habits. Consequently, this chapter re-engages with the addiction perspective, but only as applied to normal populations (see also LaRose, 2010b).

Parallel developments in the information systems literature, beginning with Limayem and Hirt (2003), found that habits were more powerful predictors of technology usage than reflective influences (e.g. derived from the Theory of Planned Behavior; TPB). Habits were later included in what is now a dominant theory in the field, the Unified Theory of Acceptance and Utilization of Technology (UTAUT2; Venkatesh, Thong, & Xu, 2012). Similar to TPB, UTAUT2 focuses on a subset of beliefs that are theorized to determine the acceptance and utilization of consumer information systems (e.g. performance, price value, and hedonic outcomes). Likewise, social norms are addressed through perceived social support for system use, and perceived behavioural control is accounted for through facilitating conditions and ease of use. Notably, habits are conceptualized on the same level as the TPB-derived concepts, with past work demonstrating their capacity to explain both intentions and later information system use.

Together, the value of habit perspectives has been established in multiple areas of research on emergent technologies over the last two decades. Concurrent efforts have integrated habit research in communication with developments in social psychology, information systems, and neuroscience (LaRose, 2010a, 2010b, 2015). This synthesis included a variety of psychological studies that employed media habits as focal behaviours (e.g. Verplanken & Orbell, 2003) and demonstrated the pervasiveness of media habits in daily life (e.g. Wood, Quinn, & Kashy, 2002). Hence, from the telegraph to the television to the computer, technology habits have long operated as key heuristic cases for the study of habitual behaviour.

Measurement Challenges

As in other literatures, technology research rewards innovators of novel pursuits, even as publication delays and overlooked developments in allied areas lead to redundancy. This is especially so when researchers respond to the latest technological innovations and social trends. Accordingly, technology habit research was already well under way in both communication and information systems prior to the publication of the Self-Report Habit Index (SRHI; Verplanken & Orbell, 2003). This led to differing, but intersecting, approaches to habit measurement that persist through today. Below, we document some of the pivotal issues that complicate tech habit operationalization before moving on to the implications for conceptualization.

Improvements upon Rubin's (1984) original habit question added statements that further conveyed the meaning of "habit" (e.g. "part of my routine") to produce reliable multiple-item scales. LaRose (2010a, 2010b) proposed recognizing all dimensions of automatic behaviour (lack of awareness, attention, intention, and control). This led to a two dimensional solution termed deficient self-observation (connoting a lack of awareness, attention) and deficient self-reaction (intention, control) (LaRose, Kim, & Peng, 2011; Tokunaga, 2015). Deficient self-observation parallels automaticity indicators in the SRHI, as became evident when SRHI items were integrated with the self-observation measure (LaRose et al., 2011). However, the SRHI does not include self-reaction indicators (e.g. "I would find hard not to do", "That would require effort not to do it") in sufficient abundance to constitute a separate dimension.

Moreover, indicators of past behavioural frequency in the established SRHI are problematic for tech habit researchers who aim to predict usage and its consequences. This issue has led to frequency-independent measures derived from the SRHI (Bayer & Campbell, 2012; Bayer, Dal Cin, Campbell, & Panek, 2016; c.f., Gardner, Abraham, Lally, & de Bruijn, 2012). Such measures of tech habits reflect automaticity, but otherwise depart from the SRHI (see Chap. 3 in this volume, for a discussion of this issue).

Other tech habit measures emerged that placed greater emphasis on the lack of control and intention dimensions of automaticity. In particular, Limayem and Hirt (2003) produced a reliable multi-item measure for information systems researchers that contained statements that parallel some found in the SRHI. However, the measure also invoked the term "addiction" and so combines the two dimensions proposed by LaRose (2010a, 2010b), while once again blurring the distinction between normal tech habits and addictions. As noted above, current information systems research is informed by UTAUT2, which deploys a subset of items that emphasizes deficient self-reaction (vs. self-observation) in two of its three items.

An array of additional tech measures tap into habit dimensions indirectly. For instance, Facebook Intensity (Ellison, Steinfield, & Lampe, 2007), which is defined as an intense relationship with Facebook, nonetheless contains some of the same basic dimensions as the SRHI. Specifically, the scale contains items relating to frequency of use and self-concept (e.g., “Facebook has become part of my daily routine”), paralleling the SRHI without using the habit label. Similar scales focusing on constructs such as “involvement” and “dependence” were developed for other online social behaviours that can appear obsessive (e.g. Walsh, White, & Young, 2010).

In addition, a plethora of technology addiction, problematic use, and compulsive use scales have been developed and adapted (see Tokunaga & Rains, 2016). As noted above, these scales are relevant since much of the extant research on problematic behaviour is focused on normal populations. Hence, such syndromes may be understood as habits that include deficient self-reaction items in their operational definitions (e.g. “try to cut down the amount of time you spend and fail?”; “stay online longer than intended?”) (LaRose, 2010a; Tokunaga, 2015; Young, 1999), and so their scales encompass further examples of habit measures.

Most recently, researchers have adopted techniques outside of standard self-report (see also *Habit Research in Action*). The Response Frequency Measure of Media Habits (RFMMH; Naab & Schnauber, 2016) asks respondents which medium they would use to achieve certain goals (e.g. entertainment) under time pressure. Although moderately correlated with the SRHI, the relatively long (3–7 s) response intervals allow for thoughtful deliberation. In turn, the measure likely reflects goal–behaviour associations that are related to habit strength at moderate levels, but may be less valid than context–behaviour associations (Neal, Wood, Labrecque, & Lally, 2012). Separately, early research on news habits has found evidence of pupil dilation while individuals view habitually consulted sources (i.e. Facebook newsfeed), as compared to a control condition without cues (Chen, Tao, Liu, & LaRose, 2018).

Conceptualization Challenges: Jingles, Jangles, Clatters, and Clamors

Conflicting operational definitions emit conceptual noise. Tech habit research is thus subject to the *jingle* problem (Thorndike, 1904); that is, habit measures such as the SRHI and UTAUT2’s habit scale share the same variable label, and even come from similar origins, yet their scales emphasize distinct dimensions of repetitive behaviour. By contrast, the SRHI and Facebook Intensity amount to a *jangle* problem (Kelley, 1927) with common measurement elements but different labels (“habits,” “intensity”). To those well-known issues, we provisionally add two new terms to describe the conceptual noise in the field. *Clatters* are similar constructs that proceed from different, incompatible paradigms—but that aim to explain the same underlying phenomenon. For example, behavioural theories (e.g. UTAUT2, TPB) and disease models (e.g. addiction, compulsion) can be said to clatter with one another. Last, we might designate *clamors*: analogous concepts and scales developed in different fields of study—but take little notice of one another. For example, communication research can be said to clamor with information systems over competing models of tech habits. Despite the apparent cacophony, the jingles, jangles, clatters, and clamors nonetheless further our understanding of the mechanisms, antecedents, and consequences of tech habits.

Causal Mechanisms of Overuse

Rising above the noise, a fundamental question about the underlying mechanisms of tech behaviour remains actively debated. In particular, does highly repetitive technology use represent a pathology that originates with chronic dysphoria, personality traits, or neurological disorders, as "disease" models imply? Empirical research suggests that only a small population of clinically addicted Internet users exists (Alter, 2017; Griffiths & Kuss, 2015; Tokunaga, 2017). Mental illness is generally marked by severe life consequences (e.g. losing friends or jobs), rather than "agree somewhat" with smartphone use complaints (Kardefelt-Winther et al., 2017; Van Deursen, Bolle, Hegner, & Kommers, 2015). Hence, the negative outcomes of technology addiction should only be correctable through professional therapeutic intervention. Yet, "addictive" use of new media is often resolved through spontaneous remission (LaRose, 2015). Accordingly, among normal populations at least, the deficient self-regulation model presents a viable alternative to the disease model (Tokunaga, 2017).

A secondary question about causal ordering also helps to resolve the clamoring of behavioural and disease models. That is, do psychosocial problems such as depression and loneliness precede or follow the development of tech habits? Examining a body of research limited to correlational evidence, Tokunaga (2017) concluded that either direction is possible for the causal arrow between problems and habits, with some evidence for cyclical patterns of causation. Hence, tech use that results in negative life consequences may originate in efforts to alleviate dysphoric states with rewarding tech behaviour (Kuss & Billieux, 2017). Unfortunately, certain users, these initial efforts may be hampered by deficient self-regulation and a spiral of mounting use (LaRose et al., 2011; van Rooij, Ferguson, van de Mheen, & Schoenmakers, 2017), especially when surrounded by encouraging others (Klimmt & Brand, 2017). Similarly, research suggests that deficient self-regulation can lead directly to negative consequences, as well as indirectly contribute through the frequency and duration of mobile use (Soror, Hammer, Steelman, Davis, & Limayem, 2015). To summarize, though tech behaviours rarely cross the threshold into problematic behaviour, habit is likely play a role in those cases.

Furthermore, more problematic tech behaviours might eventually be explained through fundamental habit mechanisms. Two distinct neural mechanisms (Smith & Graybiel, 2016), one involving ongoing interactions between automatic and deliberative processes (action–outcome habits), and another that acts independently of immediate reinforcement contingencies and defies self-control (stimulus-response habits), parallel the distinction between deficient self-observation and deficient self-reaction sides of habit automaticity. Investigations that separate self-observation (awareness, attention) from self-reaction (intention, control) find that the two facets are related (LaRose et al., 2011; Tokunaga, 2017; Van Deursen et al., 2015), although the directional arrows shift between studies and reciprocal causation remains a possibility. Therefore, future work is needed to examine whether normal and extreme users of technologies can be distinguished in terms of habitual cognition alone.

Antecedents and Consequences

The conceptual noise above raises the question of whether some individuals are more susceptible to tech habits than others. A growing list of personality facets have received recent attention as antecedents of tech habits, including trait self-regulation, impulsiveness, and sensation seeking (Bayer, Dal Cin, et al., 2016; Wilmer & Chein, 2016). Demographic, motivational, and lifestyle variables add to the list of antecedents (Van Deursen et al., 2015). For instance, a seminal UTAUT2 study found a three-way interaction effect among age, gender, and prior experience on mobile Internet use, as well as correlations between habit strength and a range of situational factors (e.g. expected performance, social influence; Venkatesh et al., 2012). In general, communication models have predicted habit strength from the expected outcomes of behaviour, self-efficacy, and depression, whereas information systems research has focused on user satisfaction and the various uses as further antecedents of tech habits (see LaRose, 2015, for a review).

Habit is also a powerful predictor of adoption and continuance for a long list of technologies, usually surpassing the strength of conscious intentions (LaRose, 2015). The sheer volume of use may partially account for both positive and negative effects, but there is reason to suspect that habit contributes beyond time commitment (Tokunaga, 2016). Online safety habits contributed to the performance of protective behaviours (Tsai et al., 2016), whereas texting habits predicted risky behaviour while driving and walking (Panek, Bayer, Dal Cin, & Campbell, 2015) and responding to phishing emails (Vishwanath, Harrison, & Ng, 2016). Studies have also documented a variety of psychosocial problems that covary with tech habits, including depression, anxiety, loneliness, and neglect of important obligations (Tokunaga & Rains, 2016). Recent time series research points to habits (vs. time displacement) as the cause of functional difficulties involving social and professional life (Tokunaga, 2016). Overall, research has introduced a wide range of antecedents and consequences of tech habits, though measurement limitations hamper the ability to disentangle key habitual mechanisms.

What Is *Special* About Tech Habits?

Amid operational and conceptual diversity, extant research on tech habits has contributed to our understanding of habit acquisition and performance in daily life. Primarily, this body of work has focused on the role of habits—in competition with other individual factors—in predicting, explaining, and regulating user behaviour. More recent perspectives, however, question whether tech habits may change human cognition at a more basic level (Barr, Pennycook, Stolz, & Fugelsang, 2015; Clayton, Leshner, & Almond, 2015; LaRose, Lin, & Eastin, 2003; Meshi, Tamir, & Heekeren, 2015; Sparrow & Chatman, 2013; Wilmer, Sherman, & Chein, 2017). National surveys (Anderson & Perrin, 2017), daily diary (Wood et al., 2002), experience sampling (Hofmann, Vohs, & Baumeister, 2012), and digital tracking (Oulasvirta, Rattenbury, Ma, & Raita, 2012) studies all suggest that tech usage accounts for a substantial proportion of complex habits in daily life. But are these habits *special*, or do such societal and academic reactions to their presence reflect a default response to encountering the new?

Prior research on tech habits has neither fully articulated whether they are theoretically (in)distinguishable from other domains of habits nor related them to the broader literature on habits. The same neurocognitive mechanisms (e.g. Smith & Graybiel, 2016) presumably explain habitual Tinder swiping as well as they do Television clicking, tooth brushing, and wallet handling. Nonetheless, new-*er* tools might provide novel cues, contexts, and rewards to develop habits, and these factors may allow for habits to manifest in (seemingly) distinctive ways. From this vantage, the study of tech habits is the study of moderation effects on habitual processes; that is, how the cues, contexts, and outcome contingencies created by emergent technologies *moderate* habit formation, performance, and change.

Increasingly, technology research has questioned the common focus on particular technologies, rather than conceptualizing or manipulating their underlying attributes. In response, some researchers have called for a greater focus on "affordances" (Evans, Pearce, Vitak, & Treem, 2017; Fox & McEwan, 2017). At a basic level, affordances represent the "possibilities for action" separating a technology (or other objects) from a user (Evans et al., 2017), typically oriented around the role of conscious or perceived functions. Nonetheless, many dimensions of technologies are "hidden" to the user (Gaver, 1991), and such dimensions may aid in the explication of tech habits. Rather than engendering a new form of cognition, tech habits may highlight how latent action possibilities influence habit mechanisms.

There are a variety of significant affordances (e.g. Fox & McEwan, 2017; Sundar, Jia, Waddell, & Huang, 2015) with the potential to influence habitual processes to some degree. On a related front, recent work has suggested that particular affordances may interact with online behaviours in the context of self-control (Hofmann, Reinecke, & Meier, 2016). Hofmann et al. (2016) highlighted four aspects that may contribute to the high level affective temptation seen in online media, including immediate gratifications, ubiquitous availability, attentional demands, and habitual usage itself. Separately, LaRose (2015) proposed a series of technological features that may influence habitual formation and change (e.g. anytime, anywhere, anonymity, anyhow). Ultimately, a parsimonious set of dimensions that will transcend specific technologies may be required to build an enduring framework—yet more groundwork is needed first.

Here, we take a sideward step by discussing how the components of a given behaviour may moderate habits via their fundamental elements: repetition, automaticity, and cueing in stable contexts (Orbell & Verplanken, 2015). The sections below explicate how the underlying components of a tech practices may influence habit action possibilities. In particular, we revisit cue and context properties of tech behaviours noted in past work, as well as outcome properties (Gardner, 2015), with the potential to moderate habit strength and performance. Certainly, the elements of repetition and automaticity are equally significant (and interwoven with the activation of contextual cues). However, we underline the latter elements due to the tendency of tech habits to challenge the meaning of "cued in stable contexts" (Orbell & Verplanken, 2015).

Cue Properties

Technologies that can be used more regularly than others inherently increase the opportunities for repeat behaviour, and thereby the likelihood and speed of habit formation. Therefore, portable technologies afford more opportunities (Schrock, 2015) for a given cue to be acquired and activated due their continual presence. In addition to allowing for more cue exposure and rapid cue–behaviour associations, portable objects (e.g. phones, boom-boxes, newspapers) inhabit more environments and thus allow for a greater variety of spatial cues to become associated with a habit. Further, online capabilities substantially widen the range of behaviours that can be performed through a given tool. Paired together, portability and connectivity bring about new layers of potential cues (Wilmer & Chein, 2016). By providing an ever-present venue, an array of physical environments, and hyperlinks to bottomless information, emergent technologies open up extra opportunities for *different* cues to form in conjunction with said habit (Bayer, Campbell, & Ling, 2016).

Online technologies are not just ubiquitous; they also provide abundant action possibilities within and between devices, applications, and features. The same behavioural "chunks" (such as a smartphone "up swipe") may become associated with multiple responses and incorporated as the starting points in various behavioural scripts. Cues may be triggered internally or externally, including the "technical cues" that emanate from a technology itself (e.g. notifications, buzzes, sounds). These attention-demanding triggers may provide for more salient cues than passive objects that lay in the background (Carden & Wood, 2018; Hofmann et al., 2016). The rising influence of personalized algorithms, in particular, may hold important implications for cue learning in the not-too-distant future. Research has also turned attention inward to delineate the contribution of different sources of cues to aggregate tech habits (e.g. smartphone checking), such as the role of spatial, technical, and mental cues that compose the global "habit" (Bayer, Campbell, & Ling, 2016; Hall, 2017). Following Neal et al. (2012), future work is needed in the tech domain to empirically identify fundamental cue patterns across technologies and individuals. The de facto standardization of particular action sequences by popular technology interfaces points to the possibility of identifying a parsimonious set of cues underlying tech habits. In total, the same technology is likely to engender many different cues, and the same habit is likely to traverse many different technologies.

Context Properties

Habits are defined to occur in stable contexts, but what is a context? Within the habit literature, contexts are most commonly treated as particular locations, situational elements, and preceding actions (Wood, 2017; Wood & Neal, 2007). Tech habits, however, are noteworthy due to their "anytime, anywhere" nature (LaRose, 2015). Portability may produce a degree of what appears to be "context-independence" (Bayer & Campbell, 2012). In many cases, it may be that the technology itself, or the embedded virtual environment, *is* the context. For example, the notification panel on a smartphone may operate as a context for interface habits. In other cases, it may be that the context is a mental state or frame of mind (in line with preceding action states), as opposed to a location or situation. For instance, the mental state of boredom may provide a context in which cues (e.g. loneliness) develop for checking the phone automatically. In this way, some tech habits are perhaps more similar to mental habits or attention habits than physical routines (Anderson, 2016; Bayer, Campbell, & Ling, 2016; Verplanken, Friborg, Wang, Trafimow, & Woolf, 2007). Given the multidimensional nature of modern tech contexts, future research may require greater attention to context operationalization.

The wide spectrum of overlapping spatial, virtual, and mental contexts also create new opportunities for different habits to become interwoven with one another. Technologies that exhibit compatibility with other habits afford faster cue associations (cf., "innovation clusters", LaRose & Hoag, 1996). Individuals may "slip" back into old habits unless new habits are highly compatible with individual routines (Labrecque, Wood, Neal, & Harrington, 2017). Entry-level smartphone habits, such as placing and receiving voice calls, may become "gateways" (Oulasvirta et al., 2012) to later habits such as texting and casual gaming. As a result, technologies that come with wide functionality, or comprehensiveness of use (Limayem, Hirt, & Cheung, 2007), allow for discrete contexts (e.g. Gmail, Facebook, Snapchat) to appear in successive bursts or become embedded in scripts (Bayer, Campbell, & Ling, 2016). Continual access to related habits lend themselves to rapid "chunking", such as swiping and password entry during habit formation. Altogether, tech habits can satisfy a variety of needs concurrently (Naab & Schnauber, 2016; Sundar & Limperos, 2013; Wang & Tchernev, 2012), and new habits are likely to develop faster, and remain stronger, as complements to old contexts.

Outcome Properties

Habit formation initially depends on the rate and size of the reward (Gardner, 2015; c.f., Wood, 2017), whether the pellets dispensed by Skinner or tweets emitted by Twitter. Although online tech often provides immediate gratifications in ways similar to sweets (Hofmann et al., 2016), such actions are not always rewarding. Rather, ever-present technologies offer instant outcomes (vs. rewards). Technologies that are characterized by certain reward schedules have the potential to facilitate stronger habitual conditioning. In particular, many technologies provide intermittent reward schedules, such as the act of checking a Twitter newsfeed that may have variable results (Vishwanath, 2016) that can increase the pace of activation and ward against extinction (James & Tunney, 2017). The contemporary state of being permanently connected (Vorderer & Kohring, 2013) offers numerous sources of intermittent rewards at semi-random times, ranging from direct messages to news headlines (van Koningsbruggen, Hartmann, & Du, 2017). Beyond primary reinforcement, versatile tools may produce secondary rewards (and punishment) associated with each catalytic cue. A cue (e.g. boredom) to check a smartwatch (e.g. Fitbit) may produce a reward by revealing the time, while also inducing secondary rewards and/or punishments (e.g. steps, badges)—all synchronously.

Emergent technologies thereby offer an amalgam of reward types, which can influence habitual processing in numerous ways. Since habit formation is especially sensitive to social rewards (Graybiel, 2008), technologies that provide social updates may allow for more powerful effects. Likewise, strict norms of social availability mean that individuals are expected to check for social updates—or face repercussions (Ling, 2012). Finally, technologies can modulate the level of delay in behavioural outcomes. Indeed, new media are defined by their interactivity (Sundar et al., 2015), producing some combination of positive, neutral, and negative rewards with minimal delay in response to user feedback. By contrast, technologies that provide locks, passwords, and silencers act as reward buffers. Depending on the tool at hand and customized settings, technologies may tighten or loosen the cue-outcome loops that facilitate habit formation (LaRose, 2015). The immediacy (e.g. clicks, beeps, bubbles, colors, numbers) of interactive habits may be established and extinguished more quickly than non-technical habits. However, once behaviours are codified as stimulus-response habits, they are relatively insensitive to negative outcomes (Smith & Graybiel, 2016; Wood, 2017).

From Problems to Prospects

As demonstrated in the above sections, tech habit research is challenged by the inherently dynamic nature of technology itself, as well as what tech habits are *perceived* to be. Societal narratives defining new-*er* habits as technology habits correspond to the "technology-as-novelty" perspective (McOmber, 1999). Technology habits reformulate the ever-changing expectations, predispositions, and practices of a given society—in line with the sociological notion of *habitus* (Bourdieu, 1977; Crossley, 2013; Papacharissi, Streeter, & Gillespie, 2013). Once a tech habit becomes part of the taken-for-granted expectations, newer technologies inevitably supplant the old in society, creating a continuing stream of research within which theories of habits may be reexamined. In other words, the new habits of today become the built-in behaviours of tomorrow. The result is that "tech habits" end up with nebulous definitions, as indicated by the long list of keywords applied to contemporary technology behaviour.

The uncertain scope of tech habits is compounded by overlap with the addiction label, particularly given the widening purview of addictive behaviour (Alter, 2017; Wiederhold, 2018). Part of the problem is that the terms "habit" and "addiction" are often used loosely outside of their central literatures (and colloquially in broader society). Although we have focused on habits in this chapter, the addiction perspective continues to collide with tech habit research. In response to early disease model investigations of "excessive" usage (now considered average levels of use), there have been growing calls to reassess the assignment of the "addiction" label across disciplines (Billieux et al., 2014; Griffiths & Kuss, 2015; Tokunaga, 2015). Most recently, criticisms about technological and other controversial addictions were funneled into exclusion criterion to limit false positives (Kardefelt-Winther et al., 2017).

Collectively, the ambiguity surrounding tech habits has implications for societies and researchers alike. Regardless of diagnostic rules, the substantial gap between the number of problem users and total users results in a conflicting narrative in society (Klimmt & Brand, 2017; Ryding & Kaye, 2017). Chun (2016) argues that, in the age of new media, habit has become even further pinned to the notion and lexicon of addiction in society. The expansive use of the addiction label may be viewed as part of the "habitus of the new" (Papacharissi et al., 2013), as a newly virtual society struggles with new conditions and potential threats. Tech habits underline the tendency of humans to fear change (sometimes reasonably; Alter, 2017). That said, accounts of spontaneous remissions of seemingly destructive tech habits are often overlooked in favor of sensational stories, at least until those habits are taken-for-granted (Ling, 2012). On the positive side, the uncertainty forces individuals and societies to reflect on the benefits and costs of tech habits (Lim, 2013), including potential tech solutions to tech problems (Klimmt & Brand, 2017). For example, recent updates include features that tweak the frequency or attractiveness of cues (e.g. greyscale interfaces, notification blockers), offering possibilities to enact habit change by changing the virtual environment (c.f., Carden & Wood, 2018).

Against this backdrop, it becomes clear that a more reflective and sustainable approach to researching tech habits is required. From a practical standpoint, different labels beget different literatures, splintering the progress being made and adding further uncertainty to the underlying mental processes. Here, we suggest the core question for tech habits is not whether basic mechanisms change as a function of newer tech (they presumably don't). Rather, the goal should be to explicate what components they employ that moderate the underlying elements of habit. None of the above components are unique to particular technologies—whether comic books or virtual reality—but they are often salient characteristics of those objects. In line with more conscious perceptions of technological affordances (Evans et al., 2017), the above components should be viewed along a spectrum. A smartphone is not the first technology tool to be portable—but it is more so than a laptop computer or a folding chair. Taking this perspective, "technology habits" represent a novel amalgam of behavioural components.

The question of how certain components affect habit mechanisms, and how various technologies align with those components, deserves empirical research. For instance, there is the potential to perform meta-analyses that reevaluate observed habit strength as a function of tech components. Going forward, a research agenda starts with research to further conceptualize and develop support for key components of tech habits, including how exactly they intersect with the basic elements of habit (Orbell & Verplanken, 2015). In line with other areas of tech research, studies seldom measure or manipulate technological attributes directly; conversely, the moderating components are typically limited to the discussion section. This may be partly due to the measurement challenges associated with extracting particular components, particularly while maintaining the real-world validity. By virtue of their complexity, however, tech habits reveal the built-in challenges involved in distinguishing standalone habits from more global sets of habits, chunks, and scripts. A century later, tech habits continue to echo Bryan and Harter's (1899) early study on the hierarchal nature of telegraph habits.

Tech habits thereby help to clarify the boundary conditions of habit mechanisms—and offer innovative avenues for future research (Carden & Wood, 2018). Indeed, the prominence of tech habits during everyday life brings about abundant opportunities to study these components in naturalistic environments. Hence, emergent methods are slated to help habit researchers unpack some of the underlying elements and components discussed above. For instance, mobile and digital methodologies (Bayer, Ellison, Schoenebeck, Brady, & Falk, 2017; Harari et al., 2016) are well-positioned to untangle the roles of spatial and virtual contexts in habit formation, while also allowing for testing hierarchal interactions of different habits (e.g. walking habits and swiping habits). Moreover, research on the moderating components of tech habits can assist in clarifying the lines between the normal habits and clinical problems. As a whole, tech habits remain well-positioned to explicate real-world habitual behaviour.

Future tech habit research should also move beyond predicting personal consequences associated with use to examine how habits contribute to broader societal concerns about technology. For example, recent research suggests that Facebook habit strength moderates the likelihood of individuals engaging in selective exposure to attitude consistent political content on the platform newsfeed (Chen et al., 2018). Among habitual users of the Facebook newsfeed, selective exposure was stronger when presented on a screen that contained familiar cues (e.g. standard logo, URL, color scheme, and layout) than comparable neutral cues. Since initial steps in a sequence of actions limit deliberations over later steps (Smith & Graybiel, 2016), this result might be explained as a weakening of critical reflection on message content once an news script was cued. Restricted deliberation following the initiation of a context cue might also explain intense online experiences such as flow states (Tokunaga, 2013) and immersive engagement (Kuru, Bayer, Pasek, & Campbell, 2017). When packaged into compact scripts, seemingly special habits paired with other unreflective forms of cognition may jointly contribute to the "addiction-like" aura of these habits (Bayer, Dal Cin, et al., 2016).

In sum, tech habits often seem “special”, even when operating through the same basic elements of past telegraphic operators. For this reason, the deconstruction of habits into component parts may help to explain the societal skepticism, and potential pathologizing, of new habits. The realization that tech “addictions” are often just new-*er* habits that appear special is not new itself; back in the 1970s, television was described as “the plug-in drug” (Winn, 1977). One does not need to be omniscient to presume that tech habits will continue to emerge that will pose theoretical and clinical obstacles to our future researchers and societies. Yet the way we approach this perpetual problem can change.

Conclusion

This chapter mapped the trajectory of contemporary tech habits, an umbrella term encompassing a growing array of new media behaviours. Due to their ubiquitous role in everyday life, tech behaviours contribute to our understanding of dynamic habits by challenging the preconceptions of standard habitual action—at least at first. Each new layer of innovation reinvigorates old concerns and promises related to the impacts of emergent technology on individual and societal well-being (Carbonell & Panova, 2017; Ryding & Kaye, 2017; Wilmer et al., 2017). To be sure, there are other innovations that are also deserving to represent the “tech habits” mantle from a mechanical standpoint (e.g. medical or transportation inventions). Those pertaining to daily information, communication, and leisure activities, however, often receive an outsized share of concerns compared to their tech brethren.

As a consequence, tech habits offer a valuable case for considering the positive and negative outcomes that result from a perennial research focus on new-*er* habits. On the positive side, research has demonstrated the immense role of habit in tech adoption and usage, as well as key antecedents and consequences—all while encountering successive waves of transformative inventions. Simultaneously, their behavioural complexity and real-world relevance makes them revealing as heuristic cases, affirming the adaptive power of habits in societal progress (or lack thereof; James, 1890). In the process, we suggest that research on tech habits helps to illuminate the hidden mechanisms and moderators supporting habitual behaviour at large.

Looking forward, this chapter suggests that researchers place greater emphasis on the underlying *components* of habitual behaviour, rather than the fleeting features of the present. Why does deconstructing the gears of tech habits matter? We propose that examining how newer technologies rely on certain components that exaggerate habitual cognition may help to explain, and to some extent justify, the uncertainty surrounding them in both societal and academic discourse. Novel combinations of cues, contexts, and outcomes can make a technology habit look powerfully, and perhaps deceivingly, *special*. With this in mind, future research should examine new-*er* habits through more generalizable paradigms, not limited to particular devices or applications, and avoid spinning the same flywheels over and over again.

Habit Research in Action

Prospects for Tuning Down the Noise

Given abundant overlap, empirical validation and integration among available measures is required, with special opportunities coming from less-obtrusive techniques. The RFMMH allows long reaction times that invite conscious reflection, and so methods that confine reactions to the millisecond range may be valuable in future work. Neuroscience studies sometimes employ reward devaluation to measure habit strength, an approach that could be applied to tech habits; for example, by removing the chroma cues or reducing the number of apps that are accessible from smartphones. Habit formation suppresses peripheral physiological responses and pupil dilation, which can be used to verify that users are responding to cues (Chen et al., 2018). Researchers have drawn on functional Magnetic Resonance Imaging (fMRI) to examine attention habits in humans (Anderson, 2016), as well as online media cognition (Meshi et al., 2015), but this approach has yet to be extended to tech habits directly.

More generally, studies are needed that compare and contrast competing measurement approaches, along with their structures, head-to-head. The tech addiction literature has produced a multitude of instruments (e.g. over a dozen forms for measuring Internet addiction). In turn, addiction instruments have spawned offshoots covering specific devices, applications, and features within applications. In contrast to habit research, most of these instruments aspire to be diagnostic instruments. Because of this, addiction measures tend to include both the consequences of use (e.g. neglect of work, school, and family and social commitments) and the habitual processes that may produce those consequences, such as deficient self-observation and self-reaction. Separation of the two components (as in LaRose et al. 2011) might help to converge the two streams of research; for example, deficient self-reaction may be well correlated with addiction items that bespeak loss of self-control. Unobtrusive physiological, neurological, and reaction time measures requiring controlled lab conditions are advancing our knowledge of habits, but establishing their relationships (if any) to self-reported and digital measures is vital to understanding technology habits in real-world environments.

References

Alter, A. (2017). *Irresistable: The rise of addictive technology and the business of keeping us hooked*. New York: Penguin Press.

Anderson, B. A. (2016). The attention habit: How reward learning shapes attentional selection. *Annals of the New York Academy of Sciences, 1369*(1), 24–39. https://doi.org/10.1111/nyas.12957

Anderson, M., & Perrin, A. (2017). Tech adoption climbs among older adults. *Pew Research Center*, (May), 1–22.

Barr, N., Pennycook, G., Stolz, J. A., & Fugelsang, J. A. (2015). The brain in your pocket: Evidence that smartphones are used to supplant thinking. *Computers in Human Behavior, 48*, 473–480. https://doi.org/10.1016/j.chb.2015.02.029

Bayer, J. B., & Campbell, S. W. (2012). Texting while driving on automatic: Considering the frequency-independent side of habit. *Computers in Human Behavior, 28*(6), 2083. https://doi.org/10.1016/j.chb.2012.06.012

Bayer, J. B., Campbell, S. W., & Ling, R. (2016). Connection cues: Activating the norms and habits of social connectedness. *Communication Theory, 26*, 128–149. https://doi.org/10.1111/comt.12090

Bayer, J. B., Dal Cin, S., Campbell, S. W., & Panek, E. (2016). Consciousness and self-regulation in mobile communication. *Human Communication Research, 42*, 71–97. https://doi.org/10.1111/hcre.12067

Bayer, J. B., Ellison, N., Schoenebeck, S., Brady, E., & Falk, E. B. (2017). Facebook in context(s): Measuring emotional responses across time and space. *New Media & Society, 20*, 1047. https://doi.org/10.1177/1461444816681522

Billieux, J., Philippot, P., Schmid, C., Maurage, P., De Mol, J., & Van der Linden, M. (2014). Is dysfunctional use of the mobile phone a behavioural addiction? Confronting symptom-based versus process-based approaches. *Clinical Psychology & Psychotherapy, 22*, 460. https://doi.org/10.1002/cpp.1910

Bourdieu, P. (1977). *Outline of a theory of practice*. Cambridge: Cambridge University Press.

Bryan, W., & Harter, N. (1899). Studies on the telegraphic language: The acquisition of a hierarchy of habits. *Psychological Review, 6*(4), 345–375. https://doi.org/10.1037/h0073117

Carbonell, X., & Panova, T. (2017). A critical consideration of social networking sites' addiction potential. *Addiction Research and Theory, 25*(1), 48–57. https://doi.org/10.1080/16066359.2016.1197915

Carden, L., & Wood, W. (2018). Habit formation and change. *Current Opinion in Behavioral Sciences, 20*, 117–122. https://doi.org/10.1016/j.cobeha.2017.12.009

Chen, C. C., Tao, C. C., Liu, M., & LaRose, R. (2018). *Automatic processes in selective news exposure among habitual Facebook users in Taiwan*. Prague, CZ: International Communication Association.

Chun, W. H. K. (2016). *Updating to remain the same: Habitual new media*. Cambridge, MA: MIT Press.

Clayton, R. B., Leshner, G., & Almond, A. (2015). The extended iSelf: The impact of iPhone separation on cognition, emotion, and physiology. *Journal of Computer-Mediated Communication, 20*(2), 119–135. https://doi.org/10.1111/jcc4.12109

Clements, J. A., & Boyle, R. (2018). Compulsive technology use: Compulsive use of mobile applications. *Computers in Human Behavior, Forthcoming*(May), 34–48. https://doi.org/10.1016/j.chb.2018.05.018

Crossley, N. (2013). Habit and habitus. *Body & Society, 19*(2–3), 136–161. https://doi.org/10.1177/1357034X12472543

DeLuca, R. (2011). *Post roads & iron horses: Transportation in connecticut from colonial times to the age of steam*. Middletown, CT: Wesleyan University Press.

Ellison, N. B., Steinfield, C., & Lampe, C. (2007). The benefits of Facebook "friends:" social capital and college students' use of online social network sites. *Journal of Computer-Mediated Communication, 12*, 1143–1168.

Evans, S. K., Pearce, K. E., Vitak, J., & Treem, J. W. (2017). Explicating affordances: A conceptual framework for understanding affordances in communication research. *Journal of Computer-Mediated Communication, 22*(1), 35–52. https://doi.org/10.1111/jcc4.12180

Fox, J., & McEwan, B. (2017). Distinguishing technologies for social interaction: The perceived social affordances of communication channels scale. *Communication Monographs, 84*(3), 298–318. https://doi.org/10.1080/03637751.2017.1332418

Gardner, B. (2015). A review and analysis of the use of "habit" in understanding, predicting and influencing health-related behaviour. *Health Psychology Review, 9*, 277–295.

Gardner, B., Abraham, C., Lally, P., & de Bruijn, G.-J. (2012). Towards parsimony in habit measurement: Testing the convergent and predictive validity of an automaticity subscale of the self-report habit index. *International Journal of Behavioral Nutrition and Physical Activity, 9*(1), 102. https://doi.org/10.1186/1479-5868-9-102

Gaver, W. W. (1991). Technology affordances. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems Reaching through Technology—CHI '91* (pp. 79–84). https://doi.org/10.1145/108844.108856

Graybiel, A. M. (2008). Habits, rituals, and the evaluative brain. *Annual Review of Neuroscience, 31*(1), 359–387. https://doi.org/10.1146/annurev.neuro.29.051605.112851

Griffiths, M. D., & Kuss, D. J. (2015). Online addictions: Gambling, video gaming, and social networking. In S. Sundar (Ed.), *The handbook of the psychology of communication technology* (pp. 384–403). New York: Wiley. https://doi.org/10.1002/9781118426456.ch17

Hall, J. (2017). The experience of mobile entrapment in daily life. *Journal of Media Psychology, 29*(3), 148–158. https://doi.org/10.1027/1864-1105/a000228

Harari, G. M., Lane, N. D., Wang, R., Crosier, B. S., Campbell, A. T., & Gosling, S. D. (2016). Using smartphones to collect behavioral data in psychological science: Opportunities, practical considerations, and challenges. *Perspectives on Psychological Science, 11*(6), 838–854. https://doi.org/10.1177/1745691616650285

Hofmann, W., Reinecke, L., & Meier, A. (2016). Of sweet temptations and bitter aftertaste: Self-control as a moderator of the effects of media use on well-being. In L. Reinecke & M. B. Oliver (Eds.), *The Routledge handbook of media use and well-being* (pp. 211–222). New York: Routledge.

Hofmann, W., Vohs, K. D., & Baumeister, R. F. (2012). What people desire, feel conflicted about, and try to resist in everyday life. *Psychological Science, 23*(6), 582–588. https://doi.org/10.1177/0956797612437426

James, W. (1890). *The principles of psychology*, Vol. 2. NY, US: Henry Holt and Company.

James, R. J. E., & Tunney, R. J. (2017). The need for a behavioural analysis of behavioural addictions. *Clinical Psychology Review, 52*, 69–76. https://doi.org/10.1016/j.cpr.2016.11.010

Kardefelt-Winther, D., Heeren, A., Schimmenti, A., van Rooij, A., Maurage, P., Carras, M., et al. (2017). How can we conceptualize behavioural addiction without pathologizing common behaviours? *Addiction, 112*(10), 1709–1715. https://doi.org/10.1111/add.13763

Kelley, T. L. (1927). Interpretation of educational measurements. *Journal of Applied Psychology, 12*, 160. https://doi.org/10.1037/h0068663

Klimmt, C., & Brand, M. (2017). Permanence of online access and internet addiction. In P. Vorderer, D. Hefner, L. Reinecke, & C. Klimmt (Eds.), *Permanently online, permanently connected: Living and communicating in a POPC World* (pp. 61–71). New York: Taylor & Francis.

Kuru, O., Bayer, J. B., Pasek, J., & Campbell, S. W. (2017). Understanding and measuring mobile Facebook use: Who, why, and how? *Mobile Media and Communication, 5*(1), 102. https://doi.org/10.1177/2050157916678269

Kuss, D. J., & Billieux, J. (2017). Technological addictions: Conceptualisation, measurement, etiology and treatment. *Addictive Behaviors, 64*, 231–233. https://doi.org/10.1016/j.addbeh.2016.04.005

Labrecque, J. S., Wood, W., Neal, D. T., & Harrington, N. (2017). Habit slips: When consumers unintentionally resist new products. *Journal of the Academy of Marketing Science, 45*(1), 119–133. https://doi.org/10.1007/s11747-016-0482-9

LaRose, R. (2010a). The problem of media habits. *Communication Theory, 20*, 194–222.

LaRose, R. (2010b). The uses and gratifications of internet addiction. In K. Young & C. N. de Abreu (Eds.), *Internet addiction handbook* (pp. 55–72). New York: Wiley.

LaRose, R. (2015). The psychology of interactive media habits. In S. Sundar (Ed.), *The handbook of the psychology of communication technology* (pp. 365–383). New York: Wiley.

LaRose, R., & Hoag, A. (1996). Organizational adoptions of the Internet and the clustering of innovations. *Telematics and Informatics, 13*(1), 49–61.

LaRose, R., Kim, J., & Peng, W. (2011). Social networking: Addictive, compulsive, problematic, or just another media habit? In Z. Papacharissi (Ed.), *A networked self* (pp. 59–81). New York: Routledge.

LaRose, R., Lin, C. A., & Eastin, M. S. (2003). Unregulated internet usage: Addiction, habit, or deficient self-regulation? *Media Psychology, 5*(3), 225–253.

Lim, S. S. (2013). On mobile communication and youth "deviance": Beyond moral, media and mobile panics. *Mobile Media and Communication, 1*(1), 96–101. https://doi.org/10.1177/2050157912459503

Limayem, M., & Hirt, S. G. (2003). Force of habit and information systems usage: Theory and initial validation. *Journal of the Association for Information Systems, 4*(4), 65–97. https://doi.org/10.1016/j.actbio.2005.04.004

Limayem, M., Hirt, S. G., & Cheung, C. M. K. (2007). How habit limits the predictive power of intention: The case of information systems continuance. *MIS Quarterly, 31*(4), 705–737.

Ling, R. (2012). *Taken for Grantedness: The embedding of mobile communication into society*. Cambridge, MA: MIT Press.

McOmber, J. B. (1999). Technological autonomy and three definitions of technology. *Journal of Communication, 49*(3), 137–153. https://doi.org/10.1111/j.1460-2466.1999.tb02809.x

Meshi, D., Tamir, D. I., & Heekeren, H. R. (2015). The emerging neuroscience of social media. *Trends in Cognitive Sciences, 19*(12), 771–782. https://doi.org/10.1016/j.tics.2015.09.004

Naab, T. K., & Schnauber, A. (2016). Habitual initiation of media use and a response-frequency measure for its examination. *Media Psychology, 19*(1), 126–155. https://doi.org/10.1080/15213269.2014.951055

Neal, D. T., Wood, W., Labrecque, J. S., & Lally, P. (2012). How do habits guide behavior? Perceived and actual triggers of habits in daily life. *Journal of Experimental Social Psychology, 48*, 492–498.

Orbell, S., & Verplanken, B. (2015). The strength of habit. *Health Psychology Review, 9*, 311. https://doi.org/10.1080/17437199.2014.992031

Oulasvirta, A., Rattenbury, T., Ma, L., & Raita, E. (2012). Habits make smartphone use more pervasive. *Personal and Ubiquitous Computing, 16*(1), 105–114. https://doi.org/10.1007/s00779-011-0412-2

Panek, E. T., Bayer, J. B., Dal Cin, S., & Campbell, S. W. (2015). Automaticity, mindfulness, and self-control as predictors of dangerous texting behavior. *Mobile Media and Communication, 3*(3), 383. https://doi.org/10.1177/2050157915576046

Papacharissi, Z., Streeter, T., & Gillespie, T. (2013). Culture digitally: Habitus of the new. *Journal of Broadcasting and Electronic Media, 57*(4), 596–607. https://doi.org/10.1080/08838151.2013.846344

Rubin, A. M. (1984). Ritualized and instrumental television viewing. *Journal of Communication, 34*(3), 67–77. https://doi.org/10.1111/j.1460-2466.1984.tb02174.x

Ryding, F. C., & Kaye, L. K. (2017). "Internet addiction": A conceptual minefield. *International Journal of Mental Health and Addiction, 16*(1), 225–232. https://doi.org/10.1007/s11469-017-9811-6

Schrock, A. R. (2015). Communicative affordances of mobile media: Portability, availability, locatability, and multimediality. *International Journal of Communication, 9*, 1229–1246.

Smith, K. S., & Graybiel, A. M. (2016). Habit formation. *Dialogues in Clinical Neuroscience, 18*(1), 33–43. https://doi.org/10.1111/clr.12458_111

Soror, A. A., Hammer, B. I., Steelman, Z. R., Davis, F. D., & Limayem, M. M. (2015). Good habits gone bad: Explaining negative consequences associated with the use of mobile phones from a dual-systems perspective. *Information Systems Journal, 25*(4), 403–427. https://doi.org/10.1111/isj.12065

Sparrow, B., & Chatman, L. (2013). Social cognition in the internet age: Same as it ever was? *Psychological Inquiry, 24*(4), 273–292. https://doi.org/10.1080/1047840X.2013.827079

Sundar, S., Jia, H., Waddell, T. F., & Huang, Y. (2015). Toward a theory of interactive media effects (TIME): Four models for explaining how Interface features affect user psychology.

In *The handbook of the psychology of communication technology* (pp. 47–86). https://doi.org/10.1002/9781118426456
Sundar, S., & Limperos, A. M. (2013). Uses and Grats 2.0: New gratifications for new media. *Journal of Broadcasting & Electronic Media, 57*, 504–525. https://doi.org/10.1080/08838151.2013.845827
Thorndike, E. L. (1904). The newest psychology. *Educational Review, 28*, 217–227.
Tokunaga, R. S. (2013). Engagement with novel virtual environments: The role of perceived novelty and flow in the development of the deficient self-regulation of internet use and media habits. *Human Communication Research, 39*(3), 365–393. https://doi.org/10.1111/hcre.12008
Tokunaga, R. S. (2015). Perspectives on internet addiction, problematic internet use, and deficient self-regulations. *Communication Yearbook, 39*, 131–161.
Tokunaga, R. S. (2016). An examination of functional difficulties from internet use: Media habit and displacement theory explanations. *Human Communication Research, 42*(3), 339–370. https://doi.org/10.1111/hcre.12081
Tokunaga, R. S. (2017). A meta-analysis of the relationships between psychosocial problems and internet habits: Synthesizing internet addiction, problematic internet use, and deficient self-regulation research. *Communication Monographs, 84*(4), 423–446. https://doi.org/10.1080/03637751.2017.1332419
Tokunaga, R. S., & Rains, S. (2010). An evaluation of two characterizations of the relationships between problematic internet use, time spent using the internet, and psychosocial problems. *Human Communication Research, 36*(4), 512–545. https://doi.org/10.1111/j.1468-2958.2010.01386.x
Tokunaga, R. S., & Rains, S. A. (2016). A review and meta-analysis examining conceptual and operational definitions of problematic internet use. *Human Communication Research, 42*(2), 165–199. https://doi.org/10.1111/hcre.12075
Tsai, H. S., Jiang, M., Alhabash, S., LaRose, R., Rifon, N. J., & Cotten, S. R. (2016). Understanding online safety behaviors: A protection motivation theory perspective. *Computers & Security, 59*, 138–150. https://doi.org/10.1016/j.cose.2016.02.009
Van Deursen, A. J. A. M., Bolle, C. L., Hegner, S. M., & Kommers, P. A. M. (2015). Modeling habitual and addictive smartphone behavior: The role of smartphone usage types, emotional intelligence, social stress, self-regulation, age, and gender. *Computers in Human Behavior, 45*, 411–420. https://doi.org/10.1016/j.chb.2014.12.039
van Koningsbruggen, G. M., Hartmann, T., & Du, J. (2017). Always on? Explicating impulsive influences on media use. In P. Vorderer, D. Hefner, L. Reinecke, & C. Klimmt (Eds.), *Permanently online, permanently connected: Living and communicating in a POPC world* (pp. 51–60). New York: Taylor & Francis.
van Rooij, A. J., Ferguson, C. J., van de Mheen, D., & Schoenmakers, T. M. (2017). Time to abandon internet addiction? Predicting problematic internet, game, and social media use from psychosocial Well-being and application use. *Clinical Neuropsychiatry, 14*(1), 113–121.
Venkatesh, V., Thong, J., & Xu, X. (2012). Consumer acceptance and user of information technology: Extending the unified theory of acceptance and use of technology. *MIS Quarterly, 36*(1), 157–178. https://doi.org/10.1111/j.1365-2729.2006.00163.x
Verplanken, B., Friborg, O., Wang, C. E., Trafimow, D., & Woolf, K. (2007). Mental habits: Metacognitive reflection on negative self-thinking. *Journal of Personality and Social Psychology, 92*(3), 526–541. https://doi.org/10.1037/0022-3514.92.3.526
Verplanken, B., & Orbell, S. (2003). Reflections of past behavior: A self-report index of habit strength. *Journal of Applied Social Psychology, 33*(6), 1313–1330.
Vishwanath, A. (2016). Mobile device affordance: Explicating how smartphones influence the outcome of phishing attacks. *Computers in Human Behavior, 63*, 198–207. https://doi.org/10.1016/j.chb.2016.05.035
Vishwanath, A., Harrison, B., & Ng, Y. J. (2016). Suspicion, cognition, and automaticity model of phishing susceptibility. *Communication Research*. https://doi.org/10.1177/0093650215627483

Vorderer, P., & Kohring, M. (2013). Permanently online: A challenge for media and communication research. *International Journal of Communication, 7*(1), 188–196. 1932-8086/2013FEA0002.

Walsh, S., White, K. M., & Young, R. M. (2010). Needing to connect: The effect of self and others on young people's involvement with their mobile phones. *Australian Journal of Psychology, 62*(4), 194–203.

Walther, J. B., & Valkenburg, P. M. (2017). Merging mass and interpersonal communication via interactive communication technology: A symposium. *Human Communication Research, 43*(4), 415–423. https://doi.org/10.1111/hcre.12120

Wang, Z., & Tchernev, J. M. (2012). The 'myth' of media multitasking: Reciprocal dynamics of media multitasking, personal needs, and gratifications. *Journal of Communication, 2004*, 493–513. https://doi.org/10.1111/j.1460-2466.2012.01641.x

Wiederhold, B. K. (2018). Stop scrolling, start living: The growing reality of internet addiction disorder. *Cyberpsychology, Behavior and Social Networking, 21*(5), 279–280. https://doi.org/10.1089/cyber.2018.29111.bkw

Wilmer, H. H., & Chein, J. M. (2016). Mobile technology habits:Â patterns of association among device usage, intertemporal preference, impulse control, and reward sensitivity. *Psychonomic Bulletin and Review, 23*(5), 1607–1614. https://doi.org/10.3758/s13423-016-1011-z

Wilmer, H. H., Sherman, L. E., & Chein, J. M. (2017). Smartphones and cognition: A review of research exploring the links between mobile technology habits and cognitive functioning. *Frontiers in Psychology, 8*(APR), 1–16. https://doi.org/10.3389/fpsyg.2017.00605

Winn, M. (1977). *The plug-in drug: Television, children, & the family*. New York: Penguin.

Wood, W. (2017). Habit in personality and social psychology. *Personality and Social Psychology Review, 21*(4), 389–403. https://doi.org/10.1177/1088868317720362

Wood, W., & Neal, D. T. (2007). A new look at habits and the habit-goal Interface. *Psychological Review, 114*(4), 843–863. https://doi.org/10.1037/0033-295X.114.4.843

Wood, W., Quinn, J. M., & Kashy, D. A. (2002). Habits in everyday life: Thought, emotion, and action. *Journal of Personality and Social Psychology, 83*(6), 1281–1297.

Young, K. S. (1999). Evaluation and treatment of internet addiction. In *Innovations in clinical practice: A source book* (Vol. 17, pp. 19–31).

Chapter 8
The Strategic Effects of State-Dependent Consumer Preferences: The Roles of Habits and Variety Seeking

Raphael Thomadsen and P. B. (Seethu) Seetharaman

Introduction

While there is large literature on habits in the psychological literature, and in other fields such as marketing that utilize the methodology from psychology, it is also the case that habits have an influence on the observed choices of consumers. Because of this, there is literature that has examined the impacts of habits using analytical theory and empirical techniques based on economic and quantitative marketing paradigms. The purpose of this chapter is to summarize that literature, and to understand the strategic considerations that occur when consumers have habits.

While this is a book on habits, there is also a behaviour that almost represents the opposite of habits: variety seeking. The extent to which these are truly opposites can be debated, but the way that these are often modelled in the economics and quantitative marketing literature reinforces the view that variety-seeking behaviour can often be interpreted as a negative habit. Thus, our summary looks at both the habit and variety-seeking literatures.

Given that the other chapters in this book cover the psychological underpinnings of habits and variety seeking, we will not touch on these topics much here. Rather, our focus is on examining how these effects have been measured in the economics and quantitative marketing literature, and more importantly, to understand the strategic implications that have come out of papers studying these effects. That is, how does the presence of habits or variety seeking change the way that firms price, set their product offerings, manage their channels or set their advertising strategy.

The basic outline of this chapter is as follows. First, because of the interdisciplinary audience for this paper, as well as the fact that the same terms may imply different things in different fields, we define the key terminology such as "habits", "state dependence" and "variety seeking" in Section "Key Terminology". In Section "How

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Habits Are Modelled", we then consider how habits are often modelled in the literature, as well as the shortcomings of these approaches. In Section "Pricing Implications", we discuss the implications of habits and variety seeking on pricing strategies. Section "Non-Price Strategic Implications" considers other strategic issues. Section "Conclusion" concludes the chapter.

Key Terminology

While it is important for different disciplines studying similar phenomena to share their insights with each other, this process is often slowed by the different language that scholars in different areas use. Thus, we clarify some of the key terminology that we use in this paper. We shy away from specifically terming these clarifications as definitions because the precise definitions of many of these terms are often debated even within each discipline.

This book is about habits. In our view habits are automatic processes that are learned from repeated responses, and are triggered through various contextual or mental cues. Habits are rarely directly measured or analyzed in economic and empirical marketing research, although similar behaviour of state dependence is often studied, and we believe that this similar behaviour gives insight into the role of habits. Further, in theoretical studies, habits and state dependence can often be thought of as equivalent concepts.

State dependence in our analysis will occur for consumers' choices when the choice a consumer makes depends on the person's past consumption history. In general, there is evidence that most state dependence is positive state dependence: consuming a product makes the consumer like the product more, which makes the consumer more likely to consume that product in the future. We call this positive or inertial state dependence. Note that while habits are a special form of state dependence, state dependence could come from other sources, too.

While theoretically the entire past history of consumption behaviour can influence a customer's choice, the relative weights that each past purchase has on today's consumption choice is likely to differ for each customer. Measuring the effect of the entire history of purchase decisions on current purchases has proven to be too complicated to measure in historical datasets such as the scanner data used in analyzing shopping behaviour. Thus, researchers have instead used simplified measures. Perhaps the most common approach is to use the last purchase as a proxy of previous shopping behaviour. The last purchase approach assumes that the customer has an increased probability of purchasing the product that the customer purchased the last time they made a purchase in that category. Thus, the last-purchase approach assumes that including a variable that indicates the product that the consumer last purchased is a reasonable approximation of the consumer's consumption state. While using this last purchase approach is imperfect, it has proven to be tractable and robust, while allowing researchers to measure different effects for different consumers.

Even though most of the state dependence literature has focused on the fact that past purchases of a product increase the probability of buying the product, this is somewhat of a simplification. Indeed, it is possible for the state dependence to be over specific attributes of the product (such as brand, size, flavor) rather than over the product itself. Our goal is not to take a side on the appropriateness of assuming state dependence over products or attributes, but to be transparent about what aspects are included in each paper that studies how state-dependent behaviour affects strategic decisions so that the reader can readily see how different concepts drive the strategic implications that we cover.

Finally, while positive state dependence is very common, it is also possible that the state dependence is negative: the purchase of a particular product may reduce the customer's utility for the same product, and because of that reduce the probability that the consumer will buy the same product, at their next purchase occasion. We term such a reduction in the probability of purchase as variety seeking. Note that variety seeking is defined to occur when the past consumption affects the utility of future consumption, and that variety seeking is not defined in terms of behaviour itself. As with state dependence, variety seeking can occur if there is a disutility of repeatedly consuming the same item, or it could represent satiation on the underlying attributes of previously chosen items, which are similar but subtly different phenomena. We will consider both phenomena in this chapter.

How Habits Are Modelled

Measuring State Dependence

Marketers have long recognized that consumers are more likely to buy products that they previously purchased. Frank (1962) examines the lengths of runs of buying the same brand and documents that the probability that consumers repurchase a brand increases in the number of previous instances they have bought that particular brand. Frank also finds that the probability that the consumer buys a particular brand declines as the amount of time elapsed since the last time they bought the brand increases. Frank attributes this behaviour to habits.

Around the same time, literature emerged on brand choice that was built on Markov process models, where the probability of buying a brand depends on the brands last purchased by the consumer. Important contributions here include those by Herniter and Magee (1961), Lipstein (1959) and Styan and Smith (1964). In such Markovian models, consumer habit would appear as a higher probability of buying one brand conditional on having bought that brand in the previous period. Massy (1966) notes that there is heterogeneity among consumers and that while several households are more likely to buy the same product that they bought on their previous trip, many other households exhibit a zeroth-order brand choice process instead, where there is no habitual component to purchasing behaviour. The observation that there may be positive correlations in choices between a household's purchase occasions, and that this correlation may simply reflect a household's underlying preference for a product rather than being indicative of a habit, is one that has been noted and tested frequently, as we discuss below.

As logit models became more popular, choice models moved largely to that framework. In an early paper estimating a logit model using scanner data, Guadagni and Little (1983) add a consumer loyalty variable into their choice model. Specifically, consumers' utility for product k is modelled as

$$U_{\mathrm{k}} = X_{\mathrm{k}}\beta + \alpha x_{\mathrm{bl}} + \varepsilon_{\mathrm{k}} \tag{8.1}$$

where x_{bl} is a "loyalty" variable that is the exponentially weighted sum of past purchases. This loyalty variable is meant to capture the extent to which a customer becomes dedicated to a specific brand, and is strongly influenced by the last purchase, but is also affected by the string of recent past purchases.

While some papers, such as Erdem (1996), have used the stream of past purchases to capture loyalty, most papers in the area have instead combined the utility approach in Eq. (8.1) with the Markov process literature and approximated "loyalty" by setting x_{bl} to 1 for the brand that was purchased the last time the customer bought a product in the same category, and 0 for all other brands. That is, most papers focus on short term state dependence rather than on habit per se. Examples include Bucklin, Gupta, and Han (1995), Che, Sudhir, and Seetharaman (2007), Dubè, Hitsch, and Rossi (2009) and Seetharaman, Ainslie, and Chintagunta (1999). Note that if consumers build a habit to buy a product and this habit evolves over time then this habit will still be captured by such a last-purchase variable, even though the functional form that is used does not directly match up with the process from which a habit is formed. This lack of fit will mean that the state dependence variable is mismeasuring the impact of habits, however. Typically, in the case of measurement error the estimated impact of the variable is attenuated, suggesting that the role of habits in choices is underestimated despite the large impact that state dependence has already been found to have on consumer choices.

Offsetting this under-measurement of the impact of habits is the fact that other factors that can explain serial dependence of choices—including heterogeneous consumer preferences and promotional activities by firms that are coordinated across time—are often not fully accounted for in the estimation of consumer behaviour. For example, in models such as Guadagni and Little (1983), where there is no consumer heterogeneity in preferences except through the model's error term, the "loyalty" variable largely captures the heterogeneity in preferences for products. However, there is a lot of evidence that the last purchase variable truly captures some aspect of state dependence (of which, habit may be a cause). For example, Keane (1997) observes that the measured state dependence shrinks when better models of heterogeneity are used, although he finds that some state dependence remains even with models that have fairly flexible forms of heterogeneous preferences. Several other papers have shown that the presence of state dependence is not merely an artifact of an incomplete specification of consumer heterogeneity: Gupta, Chintagunta, and Wittink (1997) separate preference heterogeneity and state dependence using the ordering of purchases. Erdem and Sun (2001) present a series of tests to prove the existence of state dependence. Dubè, Hitsch, and Rossi (2010) use both a flexible demand specification as well as model-free evidence to demonstrate that state dependence truly exists. For example, Dubè et al. show that the measured state dependence disappears if the ordering of the shopping trips is reshuffled. They also show that a good portion of switches prompted by price discounts lead to repeat purchases of the new products even after the price promotion has been retracted. Shin, Misra, and Horsky (2012) combine survey data and purchase data to separate heterogeneous preferences from inter-temporal effects. Further, Seetharaman et al. (1999) show that state dependence is a household characteristic that persists across categories, which would be hard to reconcile if the measured state dependence merely reflected customer heterogeneity.

What Type of State Dependence Do Consumers Exhibit?

Given that state dependence of some type has been verified to occur, it is natural to ask whether habits are the likely cause of the state dependence. Roy, Chintagunta, and Haldar (1996) allow for state dependence to enter into consumers' choices either as a variable in the consumers' utility function indicating the product that was last purchased, or directly as an increased probability of purchasing a product without accounting for the relative utilities of the product. They call the first effect "structural" state dependence and the second effect "habits". Note that the use of "structural" here is different than the use in the psychology literature, and merely reflects the use of "structure" in economics as something that affects the utility function directly. Roy et al. show that the estimated extent of habits shrinks dramatically as "structural" state dependence and consumer preference heterogeneity is added to their model.

Seetharaman (2004) builds on the work of Roy et al., and builds a more flexible model that can account for even more types of state dependence. In particular, he includes (1) lagged choices which measure what is termed to be "structural state dependence", (2) effects of serially correlated error terms, which measure what is termed as habit persistence type 1, (3) correlations of utility-maximizing alternatives, which measure what is termed as habit persistence type 2, and (4) effects of lagged marketing variables which represent carryover (e.g. advertising in one quarter can still impact choices in the next quarter). Specifically, Seetharaman models utility as

$$U_{kt} = \left(X_{kt} + \lambda_1 X_{kt-1} + \lambda_1^2 X_{kt-2} + \dots\right)\beta + \alpha\left(I_{kt-1} + \lambda_2 I_{kt-2} + \lambda_2^2 I_{kt-3} + \dots\right) + \omega_t \quad (8.2)$$

where X_{kt} are the attributes of brand k at time t, I_{kt} is an indicator variable denoting that the consumer bought brand k at time t, and $\omega_t = \left(\varepsilon_{kt} + \lambda_3 \varepsilon_{kt-1} + \lambda_3^2 \varepsilon_{kt-2} + \dots\right)$.

Seetharaman also ascribes an additional direct probability ρ that the household repeats their previous purchase without going through a utility process, similar to Roy et al. The four effects above can then be mapped to the different parameters: λ_2 measures the structural state dependence, λ_3 captures habit type 1 and ρ measures habit type 2.[1] Seetharaman finds that the effect of last-purchases directly shifting the utilities of consumers is the most-important source of state dependence. However, Seetharaman also finds evidence of habit type 1 and habit type 2, as well, and shows that ignoring these effects biases the estimated utilities.

Adamowicz and Swait (2012) use a similar model to distinguish between lagged-purchase "structural" state dependence, habit and variety seeking; however, instead of having consumer utility incorporate all of the components, the consumers decide upfront whether to engage in a habit, variety seeking or utility-maximizing process based on some cues that they receive. If they choose a habitual process, they merely purchase their last alternative. If they choose a variety-seeking process they randomly buy a new product, and if they choose a utility-maximizing product they make a choice as with a standard choice model with a last-purchase state dependence variable. The paper finds that a model that allows for all 3 types of behaviour fits better than a traditional model that incorporates only structural state dependence. In the Catsup category, approximately 25–32% of customers engage in purely habitual processes, while 9–13% of customers engage in variety-seeking behaviour. In the Yogurt category there is more utility maximization, with only 3–10% of customers buying based on habit, and 6–10% of customers engaging in pure variety-seeking behaviour. Taken together, Adamowicz and Swait (2012), Roy et al. (1996) and Seetharaman (2004) all appear to point to state dependence of the type where previous purchases enter into the customer's utility function as being the dominant form of state dependence, with other forms of habit—and perhaps variety seeking—also being present at lower levels.

In the theory literature, state dependence or variety seeking tend to be modelled using a last-purchase variable that either increases or decreases the probability that an option is chosen. One thing to note, however, is that many theory papers use models with two periods of consumption because the goal of a theory paper is to demonstrate a mechanism, and a two-period model is the simplest way to demonstrate a given mechanism. Thus, the distinction between a choice depending on the history of past purchases versus the last product that is purchased—and especially the difference between a state and a habit that has been formed over time—is less relevant in the theoretical literature than in the empirical literature. One consequence of this is that the strategic insight from these theory models applies to both habits and other forms of state dependence.

[1] Seetharaman allows for variety seeking in a similar way if $\rho < 0$. In such a situation, consumers would buy any other product with a fixed probability and buy according to their utility with the remaining probability. However, the estimates support habit over variety seeking so we simplify the exposition here.

State Dependence Over Products or Attributes

One issue that Adamowicz and Swait (2012) raise is whether habitual behaviour should be considered to take place at the product (SKU) or brand level. They argue that modeling habitual behaviour at the product level is generally best, but it is not clear from the data which of these two assumptions is better. In the variety-seeking literature there is debate about whether variety seeking is about changing products or about satiation of attributes; it may be reasonable to suppose that habits could be formed over attributes versus specific products. In the literature, some authors choose to model the state dependence as occurring over brands and others model the state dependence as occurring over products. One issue with modeling the state dependence or habits over products is that different chains of stores often have very similar products with only slightly different attributes. For example, two stores might both sell regular creamy JIF peanut butter, but one store might sell a slightly larger jar than another store. In such a case, one might reasonably believe that the habit is formed over buying creamy JIF peanut butter, but not over the size of the product. In theory one could instead decide what attributes one should use to model state dependence, but products often have only limited attributes (such as brand or product line) in the scanner datasets, limiting the number of attributes one could practically use in such a model.

As noted in the introduction, the modeling of habits and variety seeking have traditionally been related, where habits and variety seeking can be thought of as positive and negative state dependence, respectively. This concept holds at both a logical and a theory level, where variety seeking can be thought of as a factor that decreases the chance that consumers repurchase their last chosen alternative. That said, there is an issue about whether consumers want variety for variety's sake or whether the variety seeking represents a true satiation. In some papers, the variety seeking is modelled as coming from satiation in product attributes. In other papers, the variety seeking is modelled as representing a preference for changing products, even if the products are identical. This latter form more directly matches the way that variety seeking has generally been modelled in the quantitative literature, although as we note later, some authors have considered satiation in certain attributes (see Erdem, 1996, Inman, Park, & Sinha, 2008 and Lattin & McAlister, 1985). We note that the same issue actually comes up in the state dependence literature, where it is possible to develop state dependence or a habit over certain aspects of a product or over the entire product, but is usually less actively debated in the state dependence literature. For example, consumers could be state dependent about which brand of a product they purchase, or which size. Similarly, they may develop a habit towards buying certain attributes, such as being in the habit of buying fruit yogurt while not considering other new flavors that might satisfy their tastes. Even though these issues are not the focus for most quantitative analyses, they are important in all settings, especially for those analyses that focus on product differentiation.

Pricing Implications

The Impact of Inertia on Pricing

Probably the most studied question in the state dependence literature is how the presence of habits or variety seeking changes the pricing that firms should engage in. A pioneer in the field is Paul Klemperer, who studied markets with switching costs. Note that this switching cost can be thought of as a state dependence variable, where the only modeling difference is that in the case of state dependence we assume that the customer gets a boost in utility for the product they purchased last time, while in the switching cost literature we assume that there is a cost of consuming any other product. Thus, the two concepts are equivalent when comparing choices across products because the only factor that affects choice is the relative tradeoff between the two products. The main scenario where the distinction between switching costs and state dependence can matter occurs when there is an attractive outside good. Because we do not usually assume that consumers incur a switching cost when the consumer chooses the outside good but we often still assume a utility boost from state dependence when the outside good is a viable option, these situations do differ somewhat.

Klemperer (1987a) studies competition between non-differentiated products. Firms compete over two periods: in the first period, firms set simultaneous prices or quantities, and consumers then make a purchase. The same events occur in the second period—firms set simultaneous prices or quantities and then consumers make their purchase—but consumers who bought from one company in the first period must pay a switching cost if they decide to switch to the other product. If the switching costs are high enough then the firms end up with the collusive outcome in the second period. However, because of the very high profits in the second period, the firms engage in very aggressive competition in the first period. In price competition, the firms compete so aggressively that they exactly offset any gains they get in the second period from the higher margins. When firms compete by setting quantities (rather than directly setting prices), firms can be worse off in markets with switching costs than without switching costs, although Klemperer shows that the exact shape of the demand curve affects whether firms are better or worse off with switching costs. Goldfarb (2006) also notes that firms have to make sure that the size of the switching costs justifies the intensity of competition in any period where they are competing. For example, Goldfarb shows that there is a high degree of state dependence in which internet portals people visit, but the extent of state dependence in that industry did not justify the extent to which prices were subsidized as firms were building market share.

One issue with Klemperer (1987a) is the assumption that products are perfect substitutes for each other. In reality, this is rarely the case. Von Weizsäcker (1984) models a market where consumers are located on a Hotelling line, with the firms located at each end of the market. Firms set a price which stays fixed throughout the game. Consumers who have bought one product in the preceding period can switch to the other product, but must pay a switching cost to do so. Further, von Weizsäcker allows consumer tastes to change by having a consumer's location be chosen afresh again at any moment in time with a given probability. This uncertainty about future preferences means that when a customer makes a purchase today, they consider the possibility that they will be locked into the product even as their preferences move to another location. Von Weizsäcker finds that switching costs make the market pricing more competitive. The reason for this result is that consumers do not just maximize the short-term utility that they get; rather, they also recognize that they may be located somewhere else in the future. Thus, they shade towards buying lower-priced products that are less ideal for them now, leading to greater customer elasticity.

Klemperer (1987b) extends the analysis of von Weizsäcker to have a two-period game that allows prices to differ across the periods. This flexibility of pricing across periods allows for the possibility that firms will lower their prices to attract customers in the first period but raise them in the second period to exploit the lock-in. As was the case in the undifferentiated market, prices are high in the second period because of the switching costs. However, Klemperer shows that prices can also be higher than they would be in the absence of switching costs in the first period, in contrast to what one would find in a market with no switching costs. The reason behind this difference is that, consistent with the results of Farrell (1986) which studies only the second period of a differentiated switching cost game, a firm that obtains greater market share in the first period will charge a higher price than a firm that obtains a smaller market share. For customers, this means that if they buy from a lower-priced firm in the first period they will pay more in the second period. This softens the customers' incentives to switch based on price, which in turn leads the firms to price higher in the first period because undercutting a competitor does not turn out to be very fruitful.

One concern that could arise is whether the results in Klemperer (1987b) are driven by the finite horizon of the model, where firms have only an incentive to exploit customers, and not an incentive to invest in new customers, in the first period of the model. Beggs and Klemperer (1992) use an infinite-period model with consumer churn to show that prices and profits are higher than they would be in a market without switching costs. Interestingly, the paper also looks at the incentives for new firms to enter, and the higher prices make the market more attractive to new entrants compared to a market without switching costs, even though the entrant will start with no installed base of customers, similar to Farrell and Shapiro (1988).

While the above papers all consider how switching costs affect prices in a non-cooperative setting, Padilla (1995) examines how the presence of switching costs affects the ability of firms to collude. Padilla shows that the presence of switching costs can destroy the ability of firms to fully collude because it is harder for firms to punish firms that deviate from the collusive outcome. This provides another way that switching costs can reduce prices. This result is especially strong for collusion that is supported by the threat to return to non-collusive pricing if collusion breaks down, but can occur for other schemes, too, if the switching costs are large enough.

Perhaps because of the findings of Klemperer (1987b) and Beggs and Klemperer (1992), and the general sentiment from Farrell and Klemperer (2007), there has been a more-recent literature on switching costs that has shown, among other things, that switching costs may intensify competition, perhaps reflecting that real markets match the assumptions in von Weizsäcker's (1984) model more than those in Klemperer. Doganoglu (2010) uses an infinite-period model with experience goods to show that, when switching costs are low, steady-state prices and profits are lower than they would have been if switching costs had been zero. Cabral (2009, 2012) analyzes an infinite-period version of a very flexible model and shows that small switching costs lead to more competitive prices while larger switching costs lead to higher prices. This intuition can be gleaned by examining how switching costs change the incentives to invest (get more customers who are then locked in) versus harvest (increase prices on customers who are currently locked in). Cabral shows that small switching costs lead to positive incentives to harvest for firms with high market share and negative incentives to harvest for firms with low market shares. On the other hand, the incentives to invest are always great for large and small firms. Thus, the incentives to invest dominate for small switching costs.

Villas-Boas (2004) demonstrates that the question of whether the presence of switching costs lead to increased or decreased prices depends on the skewness of the valuation of each product, as well as the discount rate of both the firm and the customer. Prices tend to be lower as *firms* value the future more, while they tend to be higher as *consumers* value the future more. When the discount factors for firms and consumers are approximately equal, the presence of switching costs reduces profits. While the switching costs in Villas-Boas (2004) are derived from learning, Villas-Boas (2015) shows that the same results hold true even for exogenous switching costs. Villas-Boas (2015) also shows that the more stable preferences are, the more positive the impact of switching costs is on firm profits. Villas-Boas (2006) extends these results to an infinite-period model.

Empirically, Dubè et al. (2009) estimate a structural utility model that includes a psychological switching cost, modelled with an indicator variable for the product that was last purchased. They then examine how the steady-state prices set by the manufacturers compare to those that would be obtained in the absence of switching costs. The paper shows that prices are lower—by as much as 18%—than they would be in the absence of switching costs. Further, this decrease in price occurs even though the switching costs are of the same order of magnitude as the price of the underlying products. This is relevant because of the theory literature that shows that switching costs can decrease prices when the switching costs are small but not when they are large. While it is helpful to know the shape of this relationship, it is hard to tell what "small" means from a theory paper. Dubé et al. show that even empirically significant switching costs can lead to more-competitive markets.

While Dubé et al. show that switching costs can make markets more competitive, it is the case that switching costs in some markets do lead to higher prices. For example, Viard (2007) looks at the market for 1–800 phone numbers. Specifically, Viard looked at what happened when the government required providers to allow firms to keep their same 800 number when they switched their phone providers. Before this policy change, firms had to change their 800 number if they changed providers, imposing a significant cost especially given that many of the 800 numbers were already significantly advertised. Viard shows that allowing the portability of the 800 numbers significantly reduced the prices providers charged for the 800 numbers.

Pavlidis and Ellickson (2017) note that the state dependence that consumers exhibit could occur at either the parent brand or the sub-brand level. While Pavlidis and Ellickson confirm the findings of Dubé et al. (2009) to an extent, they find that the state dependence at the parent brand level can cause prices to have a U-shaped relationship with the level of state dependence for the dominant brand, but that increasing state dependence will always decrease prices for non-dominant brands. Thus, the relationship between pricing and the level of state dependence can be quite complex, especially for asymmetric competitors. Perhaps even more surprisingly, the presence of switching costs can make it optimal for a firm to operate each of their sub-brands separately rather than in a coordinated manner in order to be a commitment device not to price as aggressively. However, while they show that this latter effect is a theoretical possibility, they show that firms should jointly profit-maximize across each of their yogurt sub-brands in the empirical context that they consider.

Another dimension of pricing to consider is whether firms should always charge a constant price, or whether they should periodically put their product on sale. Freimer and Horsky (2008) show that firms should engage in periodic price promotions when customers have sufficiently high switching costs. In the classic case of habits, major brands should also set price promotions out of sync with each other, so they promote at different times.

To summarize these findings, state dependence has two effects on prices: on one hand there is an incentive to exploit the state dependence and increase prices, and on the other hand the ability to harvest profits from consumers later leads to more intense competition. Either of these two effects can dominate depending on many factors. However, prices are more likely to be higher when state dependence is larger or when firms have more of a short-term horizon. State dependence is more likely to decrease prices when prices remain constant over time and needs change over time.

The Impact of Variety Seeking on Pricing

As we note earlier, variety seeking behaviour is, from an analytical point of view, highly related to state-dependent loyalty behaviour in the sense that variety seeking can often be modelled as negative state dependence. Seetharaman and Che (2009) build on the model of Klemperer (1987a) and consider markets where consumers choose between two functionally undifferentiated products over two periods, but where they incur a disutility if their choice in the second period matches their choice in the first period. Thus, consumers exhibit variety seeking preferences rather than inertia or habit. They find that, as in Klemperer (1987a), firms are able to charge higher prices in the second period. This occurs because consumers are effectively locked-in to a product in period 2 just like they were with state dependence, with the only difference being that the customers are now locked in to the product they did *not* buy in the previous period. However, Seetharaman and Che show that prices are also higher in the first period of the model, in contrast with Klemperer (1987a). The reason for the softer competition and the contrast with switching costs is that when customers face switching costs then the firm gains a stream of profits by lowering prices and getting an installed base of customers. However, under variety seeking, firms gain from the customers they don't attract, who become strong potential customers for the next period. Thus, there is little incentive to compete hard in the first period.

Seetharaman and Che (2009) also examine a market that is very similar to the Klemperer (1987b) market, except that Klemperer has a number of consumers whose preferences remain constant in each period, while all customers in Seetharaman and Che obtain new preferences. Thus, variety seeking is introduced into the model both through the utility function and through the location of the firms. Seetharaman and Che then show that in this model prices are higher in both periods of a two-period game than the prices would be in the absence of variety seeking. Thus, they note that both variety seeking and inertial state dependence can both soften price competition.

Zeithammer and Thomadsen (2013) also examine how variety seeking affects pricing in a market where firms are differentiated in a quality dimension, such that all consumers agree about which products would be most or least preferred if they were all sold at the same price. For example, everyone would agree that the Ritz-Carlton hotel is nicer than a Motel 6, although consumers may differ in their willingness-to-pay for each hotel room. In their model, tastes for variety enter the utility functions as a discounted utility of a second unit of any product. The model in Zeithammer and Thomadsen also differs from many of the other models in that prices are constrained to be constant in each period reflecting the reality that prices are usually relatively stable. In this sense, the model is similar to the pricing in von Weizsäcker (1984), Doganoglu (2010) or Dubè et al. (2009). Zeithammer and Thomadsen (2013) show that when preferences for variety seeking are high, prices are also low, but when preferences for variety seeking are small, prices are high. The reason behind the result is that when preferences for variety are low, variety-seeking preferences mean that a firm that loses a customer in the first period gets an easier chance to grab that customer in the second period, while a firm that cuts its price and obtains the customer in period 1 has a hard time holding on to that customer in period 2, reducing the incentives to cut prices. However, when preferences for variety are high enough, price competition gets intense because a consumer who buys a high-quality product will not value the product as much in the second period, leading firms to compete fiercely to sell the second unit of the product.

In summary, we observe that while from a modeling point of view switching costs and variety seeking are opposites, their effects on competition are often very similar. Part of the reason for the similarity is that both of the effects lock-in, or at least bias, a set of customers to one of the companies. The main difference for these two effects is which firm obtains the locked-in customer—the firm that sold them the product in the previous period, or the one that did not sell the product.

Researchers need not commit ahead of time to whether consumers have switching costs or variety-seeking preferences. Che et al. (2007) consider a model where they estimate switching costs /variety-seeking preferences for customers. They find that while some customers exhibit variety-seeking behaviour, other customers exhibit state dependence, and the largest group of consumers exhibit neither state dependence nor variety-seeking preferences. Che et al. then look at whether firms are forward looking when they set prices. They find that firms look ahead, but only in a short-run sense.

Pricing in a Channel

While analyzing competition through a model with a direct firm-to-consumer channel provides insights into competition, most markets involve utilizing an indirect channel. Cosguner, Chan, and Seetharaman (2018) considers a channel where manufacturers sell products through retailers, which then sell their products to consumers. This is probably one of the most common channel structures that is observed in the market. Specifically, Cosguner et al. consider how switching costs change prices in the market for cola soft drinks. Cosguner et al. estimate a structural choice model, where state dependence is captured through an additive boost in utility for the product that was purchased in the previous time period, consistent with much of the empirical literature. In the model, manufacturers sell their products to retailers at a constant wholesale price. Retailers are then Stackelberg followers who sell their products to consumers. However, the firms are forward looking, and they understand that consumers who buy a product in one particular week will then get an increased utility boost if they buy that product in the next period. Cosguner et al. show that switching costs have a minimal effect on prices (with the effect being a very small increase). However, underneath the minimal impact is a more complicated pattern: Retailers are able to exploit the lock-in from consumer switching costs, so the harvest effect dominates for them and switching costs cause retailers to increase their prices. On the other hand, manufacturers face both strong harvesting and investment effects of switching costs, with the investing incentives dominating. Thus, switching costs decrease manufacturer margins and increase retailer margins. Because these two effects approximately offset empirically, the presence of switching costs amounts to a transfer from manufacturers to retailers.

Dubè, Hitsch, Rossi, and Vitorino (2008) also look at an aspect of pricing problem in the channel, considering how a retailer sets the prices across its products in the presence of state-dependent utility. The paper finds that switching costs can decrease the prices of high-quality products while increasing the prices of low-quality products. Further, switching costs increase the profits that retailers earn, although some of this effect may be the result of the positive utility that is given to products from positive state dependence versus what would be observed if one instead modelled the state dependence as negative utility from switching. Taken together with the results of Dubè et al. (2009), which should be taken as an analysis of manufacturer results, we get a similar picture as in Cosguner et al. (2018), which is that retailers should exploit the state dependence while the state dependence makes manufacturers compete more intensely. However, the Cosguner et al. analysis is more integrated and correctly accounts for the behaviour of each of the players in the channel.

Behavioural-Based Price Discrimination

Several papers have examined the role of switching costs on behavioural-based price discrimination, where consumers are charged different prices based on their past history. A key question that has come up in this literature is whether firms should charge lower prices to their previous customers or to new customers. Chen (1997) considers a two-period model of competition between two firms, each of which sells an undifferentiated product. Consumers in the first period make their purchases, and they can change which firm they buy from if they pay a switching cost, which differs by customer. One twist is that firms can reimburse customers for their switching costs—which ends up meaning that switching customers pay less than customers who do not switch. Shaffer and John Zhang (2000) look at the second stage of a similar game, except that in their paper the firms are differentiated and one firm has a more-advantageous location than the other firm. If the switching costs differ by firm, and the customers of one firm have much lower switching costs than the switching costs of the other firm, then the firm with the lower switching cost customers will offer its own customers lower prices than they offer to new customers. Otherwise firms tend to charge lower prices to their rival's customers than to their own. Taylor (2003) notes that consumers of subscription goods, which can include items such as credit cards, may choose to switch products when their switching costs are low as a way to signal their low switching costs and to separate themselves from other customers who have higher switching costs. While the resulting pattern of pricing from firms—charging a higher price to their current customers and a lower price to new customers—matches the pricing pattern found in the behaviour-based price discrimination literature even in the absence of switching costs, the fact that customers switch to signal that they have low switching costs means that it is hard for companies in these industries to hold on to their dominant market shares for a long period of time.

In a different vein, Cosguner, Chan, and Seetharaman (2017) examine behaviour-based price discrimination from another angle. In particular, they examine targeted couponing undertaken by supermarkets such as Tesco and Kroger, and study the incentives for retailers and manufacturers to offer such coupons. The paper finds that retailers should freeride off of the couponing efforts of the manufacturers, similar to the finding in Cosguner et al. (2018) that retailers exploit the state dependence in the demand, requiring the manufacturers to do all of the investment. Each manufacturer will want to coupon if neither the retailer nor the competitor is couponing.

However, if both manufacturers coupon they can each end up worse off, although in other situations this type of coupon is no longer a prisoner's dilemma.

While the above papers consider what happens under positive state dependence, Zeithammer and Thomadsen (2013) consider a market where products are differentiated by quality and where consumers have a taste for variety. They show that when firms can offer bulk discounts, there are conditions under which the high-quality firm will offer a second unit for free to those who buy a first unit. When the two firms have identical qualities (i.e. the market has no product differentiation), then both firms will offer the second unit for free to their customers. Thus, under a taste for variety there is an impetus for a firm to reward their own customers.

Non-Price Strategic Implications

What Product Should Firms Offer

While the bulk of the literature on loyalty and variety seeking focuses on pricing, there are several other elements of strategy one could consider. One key question is how switching costs affect the entry of new products into the market. Farrell and Klemperer (2007) provide a good summary of the entry literature in markets with switching costs. While much of the literature on the topic deals with whether the level of entry in the economy is socially optimal, there are a few papers that touch on issues of entry that are of more direct strategic importance. In general, Farrell and Klemperer note that there are two key effects that might lead to the presence of switching costs making entry more difficult. First, the presence of switching costs can increase the effectiveness of limit pricing in industries where there are economies of scale. Limit pricing occurs when incumbent firms price low enough to make new entry unprofitable, and economies of scale occur when the average cost to produce a unit is very large when few units are produced but the average cost is smaller when many units are produced. The presence of switching costs can mean that the price a new firm must charge in order to attract customers that already patronize a store is even lower than it would be without the presence of switching costs, making entry too difficult. Second, if habits or switching costs mean that there is a benefit of buying multiple categories in one place, then these switching costs can lead to the requirement that a new entrant sell a full product line of products across several categories, which can be difficult to do.

There is also a literature that looks at product offerings when consumers have a preference for variety. Sajeesh and Raju (2010) consider a market with two firms that are located on a Hotelling line where there are two periods of purchases. Sajeesh and Raju find that variety seeking preferences cause the firms to choose locations with less differentiation. Zeithammer and Thomadsen (2013) find a similar result in markets where products are characterized by their quality (i.e. all consumers agree which are the best and worst product). They find that firms choose to minimally differentiate themselves when the range of feasible qualities is narrow enough. The reason why variety seeking leads to lower differentiation is that the variety seeking allows the relatively undifferentiated products to all be sampled by most customers, even if prices reflect a healthy margin. More product differentiation might seem to reduce competition, but that is not quite correct because differentiation can increase the competition for the second unit of consumption.

Nguyen (2014) estimates a structural model with variety seeking to understand how variety seeking affects the number of varieties that are offered in an assortment. Nguyen finds that variety seeking is practiced mostly around flavors and less around brands. He also shows that variety seeking can increase the number of products that firms offer. However, this effect is driven by the ability of firms to capture demand from their competitors. In contrast, a monopolist may reduce the number of variants offered with variety seeking, especially if one of the products has thinner margins.

Feinberg, Kahn, and McAlister (1992) analyze competition under the model of variety seeking from Lattin and McAlister (1985). The Lattin and McAlister model takes a different view of variety seeking than many of the above papers take. Many of the above papers model variety seeking as desire for variety just for variety's sake. In contrast, Lattin and McAlister model variety seeking as coming from the satiation of attributes. Lattin and McAlister point out that one consequence of this type of variety seeking is that when consumers switch between products, these products are likely to be differentiated from each other rather than very close substitutes. Feinberg, Kahn and McAlister go further and study how this type of variety seeking affects which products gain market share. The paper shows that if two products are positioned as being similar to each other, both of the brands will lose market share—since consuming either product then leads to a decreased utility for the other product. Thus, one would expect a taste for variety to lead to increased product differentiation, especially from a less preferred brand. One might also expect advertising by the prominent brand to downplay differences between it and its smaller rivals, unless pointing out the differences would lead consumers to value the smaller brand less. Note that the different interpretation of what drives the variety seeking leads Feinberg et al. to reach the opposite conclusions as Sajeesh and Raju (2010) and Zeithammer and Thomadsen (2013).

Advertising

While the presence of state dependence or habit can affect pricing and product decisions, it can also have important implications for promotional activity. Shum (2004) investigates how advertising can counteract the state dependence that consumers experience in their purchasing of breakfast cereals. Specifically, Shum allows both the utility and the advertising sensitivity to depend on the past use of a cereal, where past use equals one for any brand that the consumer bought within the previous

12 weeks. Thus, the state dependence term is measured a little differently than in most of the papers mentioned in this article. Nevertheless, the paper finds that there are significant switching costs, and that advertising is an effective way to overcome these switching costs. For example, Shum shows that advertising might be a better way to overcome switching costs than cutting prices.

Markets with Adverse Selection

Handel (2013) studies a market where consumers exhibit strong habit—the market for health insurance—and examines how an intervention to reduce the habit affects the market. The basic source of habits is that most households will choose to buy the same health insurance policy that they had in the previous year. However, one company staged an intervention where all of the pre-existing healthcare plans were taken away and a new menu—without any default option—was presented to consumers. The consumers bought individually better plans. However, one unintended consequence of this action is that because the habit was disrupted, there was more sorting on health for the different insurance plans. This led to greater adverse selection, which caused the costs of offering some plans to increase dramatically. Thus, we observe that habit can be an important factor aiding the stability of markets with adverse selection.

Conclusion

While the study of whether consumers exhibit habits or variety seeking is a significant endeavor in its own right, it is important to note that this behaviour has important strategic implications for firms. In particular, we review economic and quantitative marketing research and see that the presence of habits can affect the price levels, and that small levels of habit likely lead to more competitive prices, but significant habitual behaviour likely leads to higher prices. Further, we have noted that the presence of habits or variety seeking can lead to more subtle effects, including how the firms should use price promotions, whether firms should engage in behaviour-based price discrimination, and whether retailers or manufacturers should harvest the higher willingness-to-pay that a habit can induce. Further, we observe that the presence of habits or variety seeking can also affect which products are introduced in to the market, as well as the advertising strategies of firms. Ultimately, the presence of state dependence has first-order implications for every element of the marketing mix, making habits and variety seeking key behavioural elements to include in any quantitative analysis.

Habit Research in Action

As seen in this chapter, economic and quantitative marketing research on habits spans many styles and topics of research. Rather than give specific advice for each type of research, we encourage researchers to follow a few broad principles. First, think about which aspects of state dependence or habit are most important to incorporate into the model, and include only those elements that are most essential. In theory papers this gives the cleanest demonstration of how habits impact the market. In empirical work, this provides the best chance of having a well-identified model. Second, in empirical applications, think about what effects the data can and cannot identify. Empirical findings should be driven by the data as much as possible. While the interpretation of what the data is telling us is often funneled through a model, it is important to understand what patterns in the data are identifying each of the different elements of the empirical model. Similarly, do your best to make sure that heterogeneous consumer preferences have been controlled for as best as possible. A particular consumer may buy a product many times in a row because they like the product, so just seeing that consumers make repeated purchases does not give us evidence of inertial effects. Rather, inertial effects must be identified from the "stickiness" of decisions through time. Finally, consider whether the state dependence is over products, brands or other attributes. Different assumptions can lead to different results—which itself gives us a lot of insight into the various ways that habit and variety seeking affect optimal managerial strategies.

References

Adamowicz, W. L., & Swait, J. D. (2012). Are food choices really habitual? Integrating habits, variety-seeking and compensatory choice in a utility-maximizing framework. *American Journal of Agricultural Economics, 95*(1), 17–41.

Beggs, A., & Klemperer, P. (1992). Multi-period competition with switching costs. *Econometrica, 60*(3), 651–666.

Bucklin, R. E., Gupta, S., & Han, S. (1995). A Brand's eye view of response segmentation in consumer brand choice behavior. *Journal of Marketing Research, 32*(1), 66–74.

Cabral, L. (2009). Small switching costs lead to lower prices. *Marketing Science, 46*(4), 449–451.

Cabral, L. (2012). *Switching costs and equilibrium prices*. Mimeo: New York University.

Che, H., Sudhir, K., & Seetharaman, P. B. (2007). Bounded rationality in pricing under state-dependent demand: Do firms look ahead, and if so, how far? *Journal of Marketing Research, 44*, 434–449.

Chen, Y. (1997). Paying customers to switch. *Journal of Economics and Management Strategy, 6*(4), 877–897.

Cosguner, K., Chan, T. Y., & (Seethu) Seetharaman, P. B. (2017). Behavioral price discrimination in the presence of switching cost. *Marketing Science, 36*(3), 426–435.

Cosguner, K., Chan, T. Y., & (Seethu) Seetharaman, P. B. (2018). Dynamic pricing in a distribution channel in the presence of switching costs. *Management Science, 64*(3), 1212–1229.

Doganoglu, T. (2010). Switching costs, experience goods, and dynamic price competition. *Quantitative Marketing and Economics, 8*(2), 167–205.

Dubè, J.-P., Hitsch, G. J., & Rossi, P. E. (2009). Do switching costs make markets less competitive? *Journal of Marketing Research, 46*(4), 435–445.

Dubè, J.-P., Hitsch, G. J., & Rossi, P. E. (2010). State dependence and alternative explanations for consumer inertia. *RAND Journal of Economics, 41*(3), 417–445.

Dubè, J.-P., Hitsch, G. J., Rossi, P. E., & Vitorino, M. A. (2008). Category pricing with state-dependent utility. *Marketing Science, 27*(3), 417–429.

Erdem, T. (1996). A dynamic analysis of market structure based on panel data. *Marketing Science, 15*(4), 359–378.

Erdem, T., & Sun, B. (2001). Testing for choice dynamics in panel data. *Journal of Business and Economic Statistics, 19*(2), 142–152.

Farrell, J. (1986). A note on inertia in market share. *Economics Letters, 21*(1), 73–75.

Farrell, J., & Klemperer, P. (2007). Coordination and lock-in: competition with switching costs and network effect. In M. Armstrong & R. Porter (Eds.), *Handbook of Industrial Organization* (Vol. 3, pp. 1967–2072).

Farrell, J., & Shapiro, C. (1988). Dynamic competition with switching costs. *RAND Journal of Economics, 19*, 123–137.

Feinberg, F. M., Kahn, B. E., & McAlister, L. (1992). Market share response when consumers seek variety. *Journal of Marketing Research, 29*, 227–237.

Frank, R. E. (1962). Brand choice as a probability process. *The Journal of Business, 35*(1), 43–56.

Freimer, M., & Horsky, D. (2008). Try it, you will like it—Does consumer learning lead to competitive price promotions? *Marketing Science, 27*(5), 796–810.

Goldfarb, A. (2006). State dependence at internet portals. *Journal of Economics and Management Strategy, 15*(2), 317–352.

Guadagni, P. M., & Little, J. D. C. (1983). A logit model of brand choice calibrated on scanner data. *Marketing Science, 2*(3), 203–238.

Gupta, S., Chintagunta, P. K., & Wittink, D. R. (1997). Household heterogeneity and state dependence in a model of purchase strings: Empirical results and managerial implications. *International Journal of Research in Marketing, 14*, 341–357.

Handel, B. (2013). Adverse selection and inertia in health insurance markets: When nudging hurts. *The American Economic Review, 103*(7), 2643–2682.

Herniter, J. D., & Magee, J. F. (1961). Customer behavior as a Markov process. *Operations Research, 9*(1), 105–122.

Inman, J. J., Park, J., & Sinha, A. (2008). A dynamic choice map approach to modeling attribute-level varied behavior among Stockkeeping units. *Journal of Marketing Research, 45*(1), 94–103.

Keane, M. P. (1997). Modeling heterogeneity and state dependence in consumer choice behavior. *Journal of Business and Economic Statistics, 15*(3), 310–327.

Klemperer, P. (1987a). Markets with consumer switching costs. *The Quarterly Journal of Economics, 102*(2), 375–394.

Klemperer, P. (1987b). The competitiveness of markets with switching costs. *RAND Journal of Economics, 18*(1), 138–150.

Klemperer, P. (1995). Competition when consumers have switching costs: An overview with applications to industrial organization, macroeconomics, and international trade. *Review of Economic Studies, 62*(4), 515–539.

Lattin, J. M., & McAlister, L. (1985). Using a variety seeking model to identify substitute and complementary relationships among competing products. *Journal of Marketing Research, 22*, 141–150.

Lipstein, B. (1959). The dynamics of brand loyalty and brand switching. *Better measurements of advertising effectiveness: the challenge of the 196's, Proceedings 5th Annual Conference of the Advertising Research Foundation, New York.*

Massy, W. F. (1966). Order and homogeneity of family specific brand-switching processes. *Journal of Marketing Research, 3*(1), 48–54.

Nguyen, D. (2014). *Switching to variety seeking: the effects of consumer variety seeking on product line strategies*. Mimeo.

Padilla, A. J. (1995). Revisiting dynamic duopoly with consumer switching costs. *Journal of Economic Theory, 67*(2), 520–530.

Pavlidis, P., & Ellickson, P. B. (2017). Implications of parent brand inertia for multiproduct pricing. *Quantitative Marketing and Economics, 15*(4), 369–407.

Roy, R., Chintagunta, P., & Haldar, S. (1996). A framework for investigating habits, "the hand of the past," and heterogeneity in dynamic brand choice. *Marketing Science, 15*(3), 280–299.

Sajeesh, S., & Raju, J. S. (2010). Positioning and pricing in a variety seeking market. *Management Science, 56*(6), 949–961.

Seetharaman, P. B. (2004). Modeling multiple sources of state dependence in random utility models: A distributed lag approach. *Marketing Science, 23*(2), 263–271.

Seetharaman, P. B., Ainslie, A., & Chintagunta, P. K. (1999). Investigating household state dependence effects across categories. *Journal of Marketing Research, 36*(4), 488–500.

Seetharaman, P. B., & Che, H. (2009). Price competition in markets with consumer variety seeking. *Marketing Science, 28*(3), 403–615.

Shaffer, G., & John Zhang, Z. (2000). Pay to switch or pay to stay: Preference-based price discrimination in markets with switching costs. *Journal of Economics and Management Strategy, 9*(3), 397–424.

Shin, S., Misra, S., & Horsky, D. (2012). Disentangling preferences and learning in brand choice models. *Marketing Science, 31*(1), 115–137.

Shum, M. (2004). Does advertising overcome brand loyalty? Evidence from the breakfast-cereal market. *Journal of Economics and Management Strategy, 13*(2), 241–272.

Styan, G. P. H., & Smith Jr., H. (1964). Markov chains applied to marketing. *Journal of Marketing Research, 1*(1), 50–55.

Taylor, C. (2003). Supplier surfing: Competition and consumer behavior in subscription markets. *RAND Journal of Economics, 34*(2), 223–246.

Viard, B. (2007). Do switching costs make markets more or less competitive? The case of 800-number portability. *RAND Journal of Economics, 38*(1), 146–163.

Villas-Boas, J. M. (2004). Consumer learning, brand loyalty, and competition. *Marketing Science, 23*(1), 134–145.

Villas-Boas, J. M. (2006). Dynamic competition with experience goods. *Journal of Economics and Management Strategy, 15*(1), 37–66.

Villas-Boas, J. M. (2015). A short survey on switching costs and dynamic competition. *International Journal of Research in Marketing, 32*, 219–222.

Von Weizsäcker, C. C. (1984). The costs of substitution. *Econometrica, 52*(5), 1085–1116.

Zeithammer, R., & Thomadsen, R. (2013). Vertical differentiation with variety-seeking consumers. *Management Science, 59*(2), 390–401.

Part II
Breaking and Creating Habits

Chapter 9
Habit Modification

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Habit Disorders

Habit disorders are repetitive behaviours that fall into categories of tics, stuttering, and nervous habits (Azrin & Nunn, 1973; Miltenberger, Fuqua, & Woods, 1998; Woods & Miltenberger, 1995). These behaviours may produce adverse physical effects such as scarring or other tissue damage and adverse social effects such as speech problems or social stigma and even interfere with adaptive or vocational functioning (American Psychiatric Association, 2013; Azrin & Nunn, 1973; Miltenberger, Fuqua, & Woods, 1998). When these behaviours occur excessively or cause distress or damage, individuals often seek treatment. The Diagnostic and Statistical Manual of Mental Disorders (5th ed.; DSM–5; American Psychiatric Association, 2013) defines a tic as a "sudden, rapid, recurrent, non-rhythmic motor movement or vocalization". Tics may be motor or vocal and also include Tourette's disorder (Miltenberger, Fuqua, & Woods, 1998). Motor tics commonly include rapid muscle movements such as head and shoulder jerking and rapid eye blinking and vocal tics commonly include grunting, coughing, clearing of the throat, sniffing, and repetitive, non-functional words. Tourette's disorder involves multiple motor tics and at least one vocal tic. The DSM-5 states that people with tics report feeling an urge or sensation (sometimes referred to as a premonitory urge) before the tic occurs and a release of tension after the tic occurs. Tics generally occur involuntarily; however, they can be controlled (American Psychiatric Association, 2013; Azrin & Peterson, 1988; Woods & Miltenberger, 1995). Stuttering consists of speech disfluencies such as word repetitions, hesitations, or "blocks" while speaking, and prolongations of words or word sounds that are caused by tensing of the oral and vocal musculature (Miltenberger, Fuqua, & Woods, 1998; Miltenberger &

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Woods, 1998). These disruptions in speech may also be accompanied by behaviours such as facial grimaces, head movements, or eye movements that contribute to the social stigmas and inconveniences experienced by people who stutter (Miltenberger, Fuqua, & Woods, 1998). Nervous habits refer to repetitive movements that involve objects or body parts and may include behaviours such as hair pulling, nail biting, thumb sucking, oral habits, skin picking, and scratching. Because the movements are centered on the body, they are also be referred to as body-focused repetitive behaviours (Woods & Miltenberger, 2001). These behaviours in particular present the potential to cause concerning physical and health problems, social and relationship problems, low self-esteem, and impairments in academic and occupational performance (Snorrason & Woods, 2014). Although Azrin and Nunn (1973) and others (e. g., Miltenberger, Fuqua, & Woods, 1998) originally included tics, stuttering, and nervous habits under the label of habit disorders and developed the habit reversal intervention to treat each of these three classes of behaviours, this chapter will focus on just one of these behaviour classes—nervous habits or body-focused repetitive behaviour disorders. We first discuss types of nervous habits, then discuss assessment and intervention with a focus on habit reversal.

Types of Nervous Habits

Nervous habits, consisting of such behaviours as hair pulling, skin picking, nail biting, mouth biting, thumb or finger sucking, and other body-focused repetitive behaviours, are prevalent, with up to 50% of college students reporting one or more habit (Teng, Woods, Twohig, & Marcks, 2002; Woods, Miltenberger, & Flach, 1996). Hair pulling or trichotillomania is classified under obsessive-compulsive and related disorders in the DSM-5 (American Psychiatric Association, 2013). For behaviour to qualify as a hair pulling disorder, there must be reoccurring hair pulling resulting in hair loss, repeated attempts to stop hair pulling, and social, occupational, or other distress resulting from hair pulling (American Psychiatric Association, 2013). Although it is no longer included in the DSM criteria for diagnosis of a hair pulling disorder, it has been reported that individuals who engage in hair pulling commonly feel a sense of tension prior to hair pulling and pleasure, gratification, or a sense of relief or release of tension or anxiety following hair pulling (Rapp, Dozier, Carr, Patel, & Enloe, 2000; Rapp, Miltenberger, Galensky, Ellingson, & Long, 1999; Snorrason & Woods, 2014). Based on these reports, it can be inferred that positive reinforcement is involved in the maintenance of hair pulling as it produces pleasure or gratification, or that negative reinforcement is involved in the maintenance of hair pulling as an unpleasant experience occurs before hair pulling and relief from that unpleasant experience occurs as a result of the behaviour. Some authors have classified hair pulling as automatic or focused with the former likely maintained by positive reinforcement and the latter likely maintained by negative reinforcement (Flessner et al., 2008; Flessner, Woods, Franklin, Cashin, & Keuthen, 2008). Secondary behaviours may also occur with or without hair pulling including hair manipulation, hair twirling, examining the pulled hair, and eating hair (Snorrason & Woods, 2014). When these behaviours occur, they may contribute to the positive reinforcement function of the behaviour (Miltenberger, Long, Rapp, Lumley, & Elliot, 1998; Rapp, Miltenberger, Galensky, Ellingson, & Long, 1999). Hair pulling commonly results in visible hair loss leading to social embarrassment, isolation, and low self-esteem, and the consumption of pulled hair can lead to build up in the digestive system that can be life-threatening (Snorrason & Woods, 2014).

Skin picking, although different in topography, is similar to hair pulling in regard to classification in the DSM-5, reports of unpleasant emotional states prior to the behaviour and change in emotional states following the behaviour, and resulting physical and social consequences (Snorrason & Woods, 2014). Thumb sucking is another nervous habit that, when occurring in excess or past a developmentally typical age, can cause dental problems, deformities in hand or fingers, and speech problems in addition to difficulties with social acceptance (Ellingson et al., 2000; Miltenberger, Long, et al., 1998; Rapp, Miltenberger, Galensky, Roberts, & Ellingson, 1999). Similarly, nail biting causes an array of physical damage including damage to cuticles, nails, nail beds, and skin around the nails especially when occurring at problematic rates (Azrin, Nunn, & Frantz, 1980a; Snorrason & Woods, 2014). Similar to hair manipulation following hair pulling, some individuals will manipulate the nail following biting and may ingest the nail or chew on it (Snorrason & Woods, 2014).

Research has also been conducted on nervous habits while public speaking (Mancuso & Miltenberger, 2016; Spieler & Miltenberger, 2017). Engaging in frequent verbal fillers and nervous habits when speaking in public can have adverse effects on others' perception of the speaker and negatively affect academic or occupational performance. The habits targeted for reduction in these studies included tongue clicks, non-functional use of the word "like", and verbal fillers including "uh", "um", and "like." Because these behaviours occur repetitively for some people while speaking in public, they can be conceptualized as habits. Research found that treatment geared toward reducing nervous habits was also successful in reducing nervous habits in public speaking (Mancuso & Miltenberger, 2016; Spieler & Miltenberger, 2017).

Functions of Habit Behaviours

From a behavioural perspective, nervous habits are conceptualized as operant behaviour or learned responses; their occurrence is affected by the conditions preceding the behaviour and the consequences that follow the behaviour (Azrin & Nunn, 1973). The function of habit behaviours is often assessed through indirect assessments such as interviews or questionnaires (e.g. Flessner, Woods, et al., 2008). Interviews or questionnaires allow the researcher to collect information on private events (emotional responses, self-talk, urges, and other personal experiences) to assess their relationship to the habit behaviour. For example, hair pullers may report a sense of tension prior to pulling and relief or gratification when pulling occurs. The function of habit behaviours is also assessed through functional analysis procedures that experimentally manipulate variables to determine their relationship to the behaviour (e.g. Rapp, Miltenberger, Galensky, Ellingson, & Long, 1999). Functional analysis procedures developed by Iwata, Dorsey, Slifer, Bauman, and Richman (1994) represent a methodology for assessing frequency of self-injurious behaviour across different environmental conditions. The frequency of behaviours in those different conditions provides insight to the variables maintaining those behaviours, which then informs appropriate intervention strategies. Although originally developed for self-injurious behaviour, functional analysis methodology can be applied with other problem behaviours including habit behaviours (e.g. Rapp, Miltenberger, Galensky, Roberts, & Ellingson, 1999). In a functional analysis, the researcher conducts test conditions in which putative social reinforcers (attention, escape from demands, access to tangible items) are delivered contingent on the behaviour and control conditions in which those reinforcers are delivered non-contingently (independent of the behaviour). If the behaviour occurs at a high rate in one of the test conditions, the results suggest that the reinforcer delivered in that condition is the reinforcer for the behaviour. A functional analysis also includes an “alone” condition in which the behaviour is observed while the child is alone to see if the behaviour persists in the absence of social reinforcement. When this is the case, the behaviour is said to be maintained by automatic reinforcement. Functional analysis research evaluating the conditions under which nervous habits occur has found that they are typically maintained by automatic reinforcement, that is, they occur independent of social reinforcement (Deaver, Miltenberger, & Stricker, 2001; Ellingson et al., 2000; Miltenberger, Long, et al., 1998; Rapp et al., 2000; Rapp, Miltenberger, Galensky, Roberts, & Ellingson, 1999). In these studies, researchers conducted functional analysis procedures and found that the nervous habits of hair pulling, hair manipulation, and finger sucking occurred most frequently in alone conditions where no social consequences were provided following the targeted behaviours. The results of these studies indicate that the nervous habits targeted are maintained by automatic positive reinforcement, specifically, varying forms of sensory stimulation. However, other reports suggest that nervous habits may be maintained by automatic negative reinforcement because their occurrence reduces feelings of tension or anxiety (Christenson & Mansueto, 1999; Miltenberger, 2005; Miltenberger, Fuqua, & Woods, 1998; Stanley, Borden, Mouton, & Breckenridge, 1995). Woods and Miltenberger (1996) found that university students engaged in more nervous habits during an “anxiety” condition in which they were told to prepare a presentation for a group, compared to a “bored” condition in which they were placed in a barren room and told to do nothing, and a neutral condition in which they viewed an entertaining video. Although Teng et al. (2002) and Woods, Miltenberger, and Flach (1996) also showed a relationship between anxiety and the occurrence of nervous habits, other researchers showed that habits were maintained by sensory stimulation (Rapp, Miltenberger, Galensky, Ellingson, & Long, 1999; Rapp, Miltenberger, Galensky, Roberts, & Ellingson, 1999). Although some nervous habits occur to reduce tension/anxiety while others produce sensory stimulation, it is generally agreed upon that habits are maintained by automatic reinforcement rather than social reinforcement (Miltenberger, Long, et al., 1998). Because these behaviours produce reinforcing outcomes that are not socially mediated, they often occur when the client is alone. As a result, in research on nervous habits, assessment consists of surreptitious observation methods such as videotaping, self-monitoring, and product measures to obtain information on their occurrence (Miltenberger, Long, et al., 1998).

Treatment for Nervous Habits

A number of interventions have been evaluated for nervous habits including habit reversal, other cognitive behavioural therapies, and contingency management procedures.

Habit Reversal

Habit reversal has been shown to be effective in reducing a wide range of nervous habits and tics (Allen, 1998; Azrin & Nunn, 1973; Azrin, Nunn, & Frantz, 1980a, 1980b; Azrin, Nunn, & Frantz-Renshaw, 1980; Azrin & Peterson, 1988, 1989, 1990; Miltenberger, Long, et al., 1998; Nunn & Azrin, 1976; Woods, Miltenberger, & Lumley, 1996). Habit reversal was originally developed by Azrin and Nunn (1973) and contained several procedures that fell within four main components: awareness training, competing response practice, habit control motivation, and generalization training. Awareness training included response description in which the habit was re-enacted and described in detail, response detection in which the client was trained to identify each occurrence of the habit, early warning detection in which the client was alerted to the earliest sign or movement of the behaviour, and situation awareness training in which the client described the environments in which the habits were most likely to occur. Competing response practice involved learning to engage in an incompatible response that would compete with the nervous habit. In the original treatment package, the competing response was not only incompatible with the tic or nervous habit but also met several other requirements including being an opposing movement to the habit, being maintained for an extended period of time, tensing muscles in the movement, strengthening opposing muscles, and remaining inconspicuous. Following each occurrence of the tic or nervous habit, clients were prompted to engage in competing response for 3 min. Habit control motivation included procedures called habit inconvenience review, social support, and public display procedure. Habit inconvenience review required the client to identify unfavorable social and personal consequences he or she experienced as a result of engaging in the nervous habit or tic. Social support involved including the client's significant others in the treatment process by having them praise the client's appearance when the habit did not occur, praise the use of competing responses, and provide prompts to engage in competing response when a habit did occur. Finally, the public display procedure required client's family and friends to observe treatment sessions and inform people in client's circle of support about the newly learned procedures. In generalization training, the client engaged in symbolic rehearsal by recalling scenarios described in situation awareness training and imagining implementing the competing response successfully when early habit movements were detected. The therapist also attempted to generalize procedures to the natural environment by engaging in casual conversation with the client and using least intrusive prompts to prompt competing responses when necessary.

Nunn and Azrin (1976) evaluated the effects of a habit reversal intervention with 13 people who engaged in nail biting and experienced negative social consequences as a result of their habit. Habit reversal procedures were slightly modified from the original components described by Azrin and Nunn (1973) to include nightly inspection of hands and nails and a fingernail-care procedure in which appropriate nail manicure skills were taught and encouraged to replace biting. Nail biting decreased by an average of 90% on the first day following habit reversal training and further decreased to near-zero levels following the first week of treatment. The habit reversal procedure was both effective and efficient as treatment sessions only took 2 h to complete. Furthermore, reduction of nail biting maintained at 16-week follow-ups for all but two participants who relapsed but returned to zero or near-zero levels after booster training session completed over the phone. Habit reversal has also been compared to negative practice for treatment of nail biting (Azrin, Nunn, & Frantz, 1980a). Similar to Nunn and Azrin (1976), habit reversal procedures in this study included instruction on appropriate nail and cuticle care, and included another novel component of inspecting and discussing nails in pairs of participants. Negative practice procedures, based on the principles of satiation and heightened awareness of the habit, involved reading written instructions, re-enacting nail biting motions with others, and then rehearsing the nail biting motions in 30-s increments every hour until the behaviours were eliminated for 4 days. Participants were then instructed to decrease the negative practice over the following 2 weeks. Both habit reversal and negative practice training were completed in one 2-h treatment session. The average results across the 97 participants demonstrated a 60% decrease in nail biting in the negative practice group and a 98% reduction in the habit reversal group. These levels of reduction maintained at 3- and 5-month follow-ups.

Azrin, Nunn, and Frantz (1980b) also compared the effectiveness of habit reversal to negative practice on the reduction of hair pulling exhibited by 34 people. The habit reversal treatment implemented in this study was closely modelled after the procedure described by Azrin and Nunn (1973) and included all four of the major original components. The negative practice intervention required participants to execute the hair pulling motions without actually pulling out the hair for a duration of 30 s every hour and continue to do so for 4 days after the habit was eliminated and then gradually fade the practice over the subsequent 2 weeks. On the first day following training, hair pulling was reduced by 58% in the negative practice group and 99% in the habit reversal group. These reduction levels generally maintained at follow-up indicating that habit reversal was the more effective intervention.

Azrin, Nunn, and Frantz (1982) found similar results when they compared habit reversal to negative practice treatment of oral habits including cheek biting, tongue biting, and lip biting and picking. This study was further evidence that habit reversal is a more effective treatment for nervous habits compared to other treatment options.

Not only has habit reversal been compared to negative practice, but it has also been compared to other treatments such as punishment procedures. Azrin, Nunn, and Frantz-Renshaw (1980) evaluated the effects of habit reversal for the reduction of thumb sucking exhibited by 32 children. The habit reversal procedure involved teaching a competing response of an incompatible hand/finger grasp, holding a nearby object, or keeping hands by side with clenched fists. The control procedure in this study involved instructions given to the children's caregivers to place an aversive tasting liquid on the child's thumb twice a day. The children in the habit reversal group decreased thumb sucking by 88% on the first day following training, and further reduced thumb sucking by 95% at monthly follow-ups whereas children in the control group decreased thumb sucking by 34–44% following treatment with the aversive tasting substance.

Following the early research by Azrin and colleagues, a number of other researchers demonstrated the effectiveness of habit reversal procedures with hair pulling, skin picking, and other nervous habits (e.g. Elliott & Fuqua, 2000; Flessner, Penzel, & Keuthen, 2010; Miltenberger, 2001; Mouton & Stanley, 1996; Tarnowski, Rosen, McGrath, & Drabman, 1987).

Researchers also demonstrated the effectiveness of habit reversal combined with other cognitive behaviour therapy (CBT) interventions such as relaxation training, cognitive restructuring, stimulus control interventions, and relapse prevention strategies for the treatment of hair pulling (e.g. Deckersbach, Wilhelm, Keuthen, Bare, & Jenike, 2002; Lerner, Franklin, Meadows, Hembree, & Foa, 1998; Tolin, Franklin, Diefenbach, Anderson, & Meunier, 2007). Still other authors demonstrated the effectiveness of habit reversal when combined with acceptance and commitment therapy for skin picking (Capriotti, Ely, Snorrason, & Woods, 2015) and hair pulling (Crosby, Dehlin, Mitchell, & Twohig, 2012; Haaland et al., 2017; Woods, Wetterneck, & Flessner, 2006) and when combined with dialectic behaviour therapy for hair pulling (Keuthen et al., 2010). These studies demonstrate the effectiveness of habit reversal alone and combined with other CBT procedures.

Although research shows habit reversal has robust effects when used alone or in a treatment package, other researchers evaluated simplified versions of habit reversal to determine whether the treatment could be made more efficient. These simplified versions consisted of awareness training and competing response training, sometimes in combination with social support. Researchers showed the simplified versions to be effective for hair pulling (Rapp, Miltenberger, Long, Elliott, & Lumley, 1998), skin picking (Teng, Woods, & Twohig, 2006; Twohig & Woods, 2001; Woods & Twohig, 2001), and nail biting (Twohig, Woods, Marcks, & Teng, 2003). Miltenberger, Fuqua, and McKinley (1985) conducted the first component analysis study when they evaluated the effectiveness of the habit reversal treatment package and a simplified habit reversal package for the reduction of motor tics in nine people. The simplified habit reversal group was only exposed to awareness training and competing response training. Results indicated that both the habit reversal and simplified habit reversal treatments were effective in substantially reducing tics. Validation of the efficacy of a simplified procedure may lead to improved treatment delivery by practitioners and compliance by those receiving treatment. Furthermore, isolating components of this procedure may lead to important information about the variables maintaining nervous habits and tics, which can then lead to a better conceptual understanding of the behaviours and how they relate the findings of other researchers (Miltenberger et al., 1985). Miltenberger and Fuqua (1985) then examined the effects of contingent versus non-contingent competing response practice for nervous habits. All participants were exposed to one treatment session consisting of awareness training and either contingent competing response practice or non-contingent competing response practice. Participants in the contingent competing response group were taught an incompatible response to perform for 3 min following each instance of a nervous habit. Participants in the non-contingent competing response group were taught an incompatible response to perform throughout the day regardless of when they engaged in a nervous habit. Results indicated that the contingent competing response practice was effective in reducing nervous habits for most of the participants, and the non-contingent competing response practice was not effective. These results indicate that competing response practice is an essential component of the habit reversal practice, and when implemented, the competing response must be performed contingent upon the occurrence of the nervous habit targeted for reduction. In other research on simplified habit reversal, Rapp, Miltenberger, Long, Elliott, and Lumley (1998) showed the intervention was effective for decreasing the hair pulling of three adolescents and Twohig and Woods (2001) and Teng et al. (2006) demonstrated its effectiveness for decreasing skin picking exhibited by adults. Research has also shown that simplified habit reversal is successful in decreasing nervous habits associated with public speaking (Mancuso & Miltenberger, 2016). In this study, university students decreased the frequency of nervous habits, referred to as “filled pauses”, consisting of saying “uh”, “um”, “like”, and other fillers when engaged in public speaking when they implemented awareness training and competing response training.

There has also been component analysis research that suggests awareness training may be an effective intervention on its own, thus further simplifying the habit reversal methodology. Ladouceur (1979) compared traditional habit reversal to habit reversal and self-monitoring, self-monitoring alone, self-monitoring and daily graphing, and a control group receiving no treatment, for 50 participants engaging in chronic nail biting. The four experimental groups demonstrated equal reduction in nail biting compared to the control group suggesting that competing response training may not be necessary to achieve a reduction in nervous habits. In another study evaluating awareness training alone as treatment for nervous habits in public speaking, Spieler and Miltenberger (2017) showed that awareness training decreased filled pauses during public speaking by college students. The results showed similar reductions in frequency as obtained by Mancuso and Miltenberger (2016) with awareness training and competing response training. Other researchers have shown that awareness training alone is also effective in decreasing tics exhibited by children and adults. Ollendick (1981) evaluated the effects of self-monitoring on nervous tics exhibited by two children and found that self-monitoring alone was a sufficient intervention to eliminate one child's tic, whereas the other child required the addition of competing response training to self-monitoring to achieve a similar reduction. Somewhat similar results were found by Woods, Miltenberger, and Lumley (1996) when awareness training alone effectively eliminated a tic for one child, but the other children required additions of self-monitoring and competing response training. Wright and Miltenberger (1987) found that an awareness training intervention consisting of response description, response detection, and self-recording was effective in decreasing head and facial tics for a college student. In their analysis of the mechanisms responsible for the effectiveness of awareness training, the authors posit that, due to awareness training, the occurrence of the tics became aversive in nature, and the participant may have acted to suppress his tics because doing so was maintained by negative reinforcement. In one other study, awareness training was also found to be effective in eliminating several tics demonstrated by a child diagnosed with Tourette's disorder, ADHD, and Asperger's syndrome (Wiskow & Klatt, 2013). This finding was interesting considering that awareness training was demonstrated to be effective with someone with multiple diagnoses, as other research has pointed to the ineffectiveness of habit reversal with individuals with developmental and intellectual disabilities (Rapp, Miltenberger, & Long, 1998). Typically, this population requires the addition of adjunct or alternative procedures to decrease nervous habits and tics.

Other Behavioural Interventions

When habit reversal is not effective or not appropriate for the individual with the habit, other behavioural interventions may be more appropriate. Habit reversal may not be appropriate for individuals who are not motivated to decrease their habit behaviour because it causes no distress or negative consequences for them, or for individuals who may not have the cognitive capacity or ability to carry out what is essentially a self-management procedure. Long, Miltenberger, Ellingson, and Ott (1999) examined the effectiveness of a simplified habit reversal procedure for the reduction of nail biting and oral-digital nervous habits of four participants with intellectual disabilities. The simplified habit reversal package consisting of awareness training, competing response training, and social support was effective for only one of the participants. This participant was also exposed to a differential reinforcement contingency following simplified habit reversal (in which he received $5 at the end of each week he demonstrated appropriate nail growth and care) to further reduce the occurrence of nail biting. The other individuals required the addition of adjunct procedures including remote prompting, differential reinforcement, and response cost. In the remote prompting condition, prompts to engage in a competing response were provided contingent upon each occurrence of the habit remotely from another room via a speaker. The differential reinforcement and response cost procedures involved delivery of dimes contingent upon engaging in competing responses and refraining from engaging in habit behaviours and removal of dimes earned following occurrence of habit behaviours. The authors speculate that the simplified habit reversal procedure may have been successful for the first participant because he had reported being embarrassed by his nervous habit and the appearance of his nails and had previously attempted to stop biting his nails on his own. Therefore, he may have been more motivated to reduce nail biting compared to the other participants who did not report experiencing negative social consequences as a result of their behaviours. Long, Miltenberger, and Rapp (1999) also used differential reinforcement and response cost contingencies with a typically developing 6-year-old girl engaging in thumb sucking and hair pulling after simplified habit reversal and booster training sessions were ineffective. Differential reinforcement substantially reduced the behaviours and the addition of response cost further reduced the behaviours to near-zero levels. Similar to the participants who required adjunct procedures in the study by Long et al. (1999), this young girl did not report any unfavorable social consequences resulting from her habit behaviours. This finding supports recommendations to evaluate an individual's motivation, cognitive level, and age to determine the most suitable and effective intervention for that individual. Other researchers also showed that the effectiveness of habit reversal was enhanced with additional behavioural procedures for use with children (Conelea & Klein-Tasman, 2013; Romaniuk, Miltenberger, & Deaver, 2003).

For individuals with intellectual disabilities, habit reversal may be ineffective if they cannot reliably identify when they engage in a habit behaviour. As research has demonstrated, awareness training is an essential component of the habit reversal procedure, and if one cannot become aware of the behaviour, additional procedures may be necessary to achieve a reduction in the behaviour. Rapp, Miltenberger, and Long (1998) implemented a simplified habit reversal procedure with a 36-year-old woman with moderate intellectual disability who engaged in chronic hair pulling and hair manipulation. Simplified habit reversal only yielded minimal decreases in hair pulling. Due to speculation that the minimal results may have been attributed to difficulty identifying instances of hair pulling, the authors introduced an awareness enhancement device (AED). The AED emitted a tone when the participant's hand approached her head and thus served as a signal to engage in her competing response. The introduction of the AED immediately reduced hair pulling to near-zero levels. Stricker, Miltenberger, Garlinghouse, Deaver, and Anderson (2001) also found that implementation of an AED successfully eliminated thumb sucking for two children diagnosed with ADHD. Although the tone may have simply served to increase awareness of thumb sucking, it is also possible that the tone emitted by the AED became an aversive stimulus. Therefore, thumb sucking was punished because it produced the tone and behaviour that terminated or prevented thumb sucking was negatively reinforced because it removed or avoided the tone. Further research by Stricker, Miltenberger, Garlinghouse, and Tulloch (2003) found that the AED alone was not sufficient to reduce finger sucking in a 6-year-old girl diagnosed with ADHD. The experimenters then added an additional remote-controlled 90-dB buzzer to the AED and found that the more intense stimulus successfully eliminated the finger sucking. The literature on awareness enhancement devices indicates it may be an effective strategy for reducing nervous habit behaviours especially for those that have intellectual disabilities, are young, or are not motivated to decrease their behaviours; however, the stimulus intensity may need to be adjusted. Interestingly, Himle, Perlman, and Lokers (2008) also showed that an awareness enhancing and monitoring device that sounded a tone when hair pulling occurred was successful in decreasing hair pulling by three adults without intellectual disabilities. This finding suggests that such a device may have wider applicability for treatment of hair pulling. However, more research is needed to establish its effectiveness and acceptability (e.g. Himle et al., 2018).

Summary

Nervous habits are prevalent among the general population but when they occur excessively or cause distress or damage, individuals may seek treatment. It is thought that nervous habits occur because they function to modulate arousal, either providing stimulation or providing momentary reduction in tension or anxiety or relief from unpleasant emotions. Habit reversal, the most commonly used intervention for nervous habits, has been shown to be effective with adults and children when used alone or in conjunction with other interventions. Habit reversal is less effective for individuals with intellectual disabilities or young children who are not motivated to seek treatment. In such cases, other behavioural interventions may be effective.

Habit Research in Action

Although randomized controlled trials have been conducted to evaluate habit reversal, much of the research in the treatment of nervous habits utilizes behavioural research methods characterized by direct observation assessment of the target behaviour, using repeated measures over time, and within person or time series research designs that evaluate treatment effectiveness through visual analysis of graphed data.

After the research question has been established and an appropriate research design chosen, the research process starts with the selection of participants who are seeking intervention for habit behaviours that are causing distress, thus motivating them (or their parents) to seek treatment. Participants can be recruited through a specialty clinic or from the general public through advertising.

The researcher then defines the target behaviour to be recorded and designs a behaviour recording plan. Target behaviours are defined in objective terms so that two independent observers could agree on the occurrence of the behaviour. Throughout the data collection period, a second observer regularly observes the target behaviour so inter-observer agreement can be assessed.

The development of a behaviour recording plan requires the researcher to identify a time and place in which the behaviour is likely to occur and arrange for direct observation of the behaviour in that context. Typically the target behaviour is observed while the participant is alone as most habit behaviours occur when the participant is alone. In some studies, the target behaviour is recorded in the home of the child through direct observation via video recording and in some circumstances the target behaviour is recorded by an observer through an observation window as the participant is engaging in an activity alone in a research room. Often the duration of the habit behaviour is recorded in the observation period and reported as a percentage of time (duration of the behaviour divided by duration of the observation period). In some studies, momentary time sample is used as an estimate of the occurrence of the behaviour. For example, once every 5 min a parent might peek into the room where the child is watching television alone and record whether the child is pulling her hair at the time of the observation. The data are then reported as the percentage of observations with the habit behaviour (e.g. Romaniuk et al., 2003). The behaviour recording plan is carried out in the same fashion before intervention (baseline) and then once intervention is implemented.

Within-person research designs evaluate experimental control through (a) demonstration of behaviour change with the introduction of treatment and (b) replication within person or between persons. In habit research, replication is most often demonstrated across participants, often with the use of a multiple baseline across participants design. In this research design, intervention is first implemented for one participant while two or more other participants are still in baseline. After intervention produces behaviour change for the first participant, intervention is then applied to the second participant while the remaining participants remain in baseline. This process continues for the remaining participants. By staggering intervention over time across multiple participants and showing behaviour change each time intervention is implemented, experimental control is demonstrated. The effectiveness of the intervention is judged through visual inspection of the data—are clinically significant changes observed in the habit behaviour each time the intervention is implemented for a participant? A clinical significant change would be a decrease to a zero or near-zero level of the behaviour during intervention.

References

Allen, K. D. (1998). The use of an enhanced simplified habit-reversal procedure to reduce disruptive outbursts during athletic performance. *Journal of Applied Behavior Analysis, 31*, 489–492.

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Arlington, VA: American Psychiatric Publishing.

Azrin, N. H., & Nunn, R. G. (1973). Habit-reversal: A method of eliminating nervous habits and tics. *Behaviour Research and Therapy, 11*, 619–628.

Azrin, N. H., Nunn, R. G., & Frantz, S. E. (1980a). Habit reversal versus negative practice treatment of nail biting. *Behaviour Research and Therapy, 18*, 281–285.

Azrin, N. H., Nunn, R. G., & Frantz, S. E. (1980b). Treatment of hair pulling (trichotillomania): A comparative study of habit reversal and negative practice training. *Journal of Behavior Therapy and Experimental Psychiatry, 11*, 13–20.

Azrin, N. H., Nunn, R. G., & Frantz, S. E. (1982). Habit reversal vs negative practice treatment of self-destructive oral habits (biting, chewing or licking of the lips, cheeks, tongue or palate). *Journal of Behavior Therapy and Experimental Psychiatry, 13*, 49–54.

Azrin, N. H., Nunn, R. G., & Frantz-Renshaw, S. (1980). Habit reversal treatment of thumb sucking. *Behaviour Research and Therapy, 18*, 395–399.

Azrin, N. H., & Peterson, A. L. (1988). Habit reversal for the treatment of Tourette syndrome. *Behaviour Research and Therapy, 26*, 347–351.

Azrin, N. H., & Peterson, A. L. (1989). Reduction of an eye tic by controlled blinking. *Behavior Therapy, 20*, 467–473.

Azrin, N. H., & Peterson, A. L. (1990). Treatment of Tourette syndrome by habit reversal: A waiting-list control group comparison. *Behavior Therapy, 21*, 305–318.

Capriotti, M., Ely, L., Snorrason, I., & Woods, D. (2015). Acceptance-enhanced behavior therapy for excoriation (skin-picking) disorder in adults: A clinical case series. *Cognitive and Behavioral Practice, 22*, 230–239.

Christenson, G. A., & Mansueto, C. S. (1999). Trichotillomania: Descriptive characteristics and phenomenology. In M. B. Stein, G. A. Christenson, & E. Hollander (Eds.), *Trichotillomania* (pp. 1–41). Washington, DC: American Psychiatric Press.

Conelea, C. A., & Klein-Tasman, B. P. (2013). Habit reversal therapy for body-focused repetitive behaviors in Williams syndrome: A case study. *Journal of Developmental and Physical Disabilities, 25*, 597–611.

Crosby, J., Dehlin, J., Mitchell, P., & Twohig, M. (2012). Acceptance and commitment therapy and habit reversal training for the treatment of trichotillomania. *Cognitive and Behavioral Practice, 19*, 595–605.

Deaver, C. M., Miltenberger, R. G., & Stricker, J. M. (2001). Functional analysis and treatment of hair twirling in a young child. *Journal of Applied Behavior Analysis, 34*, 535–538.

Deckersbach, T., Wilhelm, S., Keuthen, N., Bare, L., & Jenike, M. (2002). Cognitive behavior therapy for self-injurious skin picking. *Behavior Modification, 26*, 361–377.

Ellingson, S. A., Miltenberger, R. G., Stricker, J. M., Garlinghouse, M. A., Roberts, J., Galensky, T. L., et al. (2000). Analysis and treatment of finger sucking. *Journal of Applied Behavior Analysis, 33*, 41–52.

Elliott, A., & Fuqua, R. W. (2000). Trichotillomania: Conceptualization, measurement, and treatment. *Behavior Therapy, 31*, 529–545.

Flessner, C., Conelea, C., Woods, D., Franklin, M., Keuthen, N., & Cashin, S. (2008). Styles of pulling in trichotillomania: Exploring differences in symptom severity, phenomenology, and functional impact. *Behaviour Research and Therapy, 46*, 345–357.

Flessner, C., Penzel, F., & Keuthen, N. (2010). Current treatment practices for children and adults with trichotillomania: Consensus among experts. *Cognitive and Behavioral Practice, 17*, 290–300.

Flessner, C., Woods, D., Franklin, M., Cashin, S., & Keuthen, N. (2008). The Milwaukee Inventory of Subtypes of trichotillomania-Adult Version (MIST-A): Development of an instrument for the assessment of “focused” and “automatic” hair pulling. *Journal of Psychopathology and Behavioral Assessment, 30*, 20–30.

Haaland, A., Eskeland, S., Moen, E., Vogel, P., Haseth, S., Mellingen, K., et al. (2017). ACT-enhanced behavior therapy in group format for trichotillomania: An effectiveness study. *Journal of Obsessive-Compulsive and Related Disorders, 12*, 109–116.

Himle, J., Bybee, D., O’Donnell, L., Weaver, A., Vinka, S., DeSena, D., et al. (2018). Awareness enhancing and monitoring device plus habit reversal in the treatment of trichotillomania: An open feasibility trial. *Journal of Obsessive-Compulsive and Related Disorders, 16*, 14–20.

Himle, J., Perlman, D., & Lokers, L. (2008). Prototype awareness enhancing and monitoring device for trichotillomania. *Behaviour Research and Therapy, 46*, 1187–1191.

Iwata, B. A., Dorsey, M. F., Slifer, K. J., Bauman, K. E., & Richman, G. S. (1994). Toward a functional analysis of self-injury. *Journal of Applied Behavior Analysis, 27*, 197–209.

Keuthen, N. J., Rothbaum, B. O., Welch, S. S., Taylor, C., Falkenstein, M., Heekin, M., et al. (2010). A pilot trial of dialectical behavior therapy-enhanced habit reversal for trichotillomania. *Depress and Anxiety, 27*, 953–959.

Ladouceur, R. (1979). Habit reversal treatment: Learning an incompatible response or increasing the subject's awareness? *Behaviour Research and Therapy, 17*, 313–316.

Lerner, J., Franklin, M., Meadows, E., Hembree, E., & Foa, E. (1998). Effectiveness of a cognitive behavioral treatment program for trichotillomania: An uncontrolled investigation. *Behavior Therapy, 29*, 157–171.

Long, E. S., Miltenberger, R. G., Ellingson, S. A., & Ott, S. M. (1999). Augmenting simplified habit reversal in the treatment of oral-digital habits exhibited by individuals with mental retardation. *Journal of Applied Behavior Analysis, 32*, 353–365.

Long, E. S., Miltenberger, R. G., & Rapp, J. T. (1999). Simplified habit reversal plus adjunct contingencies in the treatment of thumb sucking and hair pulling in a young child. *Child & Family Behavior Therapy., 21*, 45–58.

Mancuso, C., & Miltenberger, R. (2016). Using habit reversal to decrease filled pauses and nervous habits in public speaking. *Journal of Applied Behavior Analysis, 49*, 188–192.

Miltenberger, R. (2001). Habit reversal treatment manual for trichotillomania. In D. W. Woods & R. G. Miltenberger (Eds.), *Tic disorders, trichotillomania, and other repetitive behavior disorders: Behavioral approaches to analysis and treatment* (pp. 171–196). New York: Springer.

Miltenberger, R. G. (2005). The role of automatic negative reinforcement in clinical problems. *International Journal of Behavioral Consultation and Therapy, 1*, 1–11.

Miltenberger, R. G., & Fuqua, R. W. (1985). A comparison of contingent versus noncontingent competing response practice in the treatment of nervous habits. *Journal of Behavior Therapy and Experimental Psychiatry, 16*, 195–200.

Miltenberger, R. G., Fuqua, R. W., & McKinley, T. (1985). Habit reversal with muscle tics: Replication and component analysis. *Behavior Therapy, 16*, 39–50.

Miltenberger, R. G., Fuqua, R. W., & Woods, D. W. (1998). Applying behavior analysis to clinical problems: Review and analysis of habit reversal. *Journal of Applied Behavior Analysis, 31*, 447–469.

Miltenberger, R. G., Long, E. S., Rapp, J. T., Lumley, V. A., & Elliot, A. J. (1998). Evaluating the function of hair pulling: A preliminary investigation. *Behavior Therapy, 29*, 211–219.

Miltenberger, R., & Woods, D. (1998). Disfluencies. In S. Watson, & F. Gresham (Eds.), *Handbook of child behavior therapy* (pp. 127–142). New York: Plenum.

Mouton, S., & Stanley, M. (1996). Habit reversal training for trichotillomania: A group approach. *Cognitive and Behavioral Practice, 3*, 159–182.

Nunn, R. G., & Azrin, N. H. (1976). Eliminating nail-biting by the habit reversal procedure. *Behaviour Research and Therapy, 14*, 65–67.

Ollendick, T. H. (1981). Self-monitoring and self-administered overcorrection: The modification of nervous tics in children. *Behavior Modification, 5*, 75–84.

Rapp, J., Miltenberger, R., Long, E., Elliott, A., & Lumley, V. (1998). Simplified habit reversal for chronic hair pulling in three adolescents: A clinical replication with direct observation. *Journal of Applied Behavior Analysis, 31*, 299–302.

Rapp, J. T., Dozier, C. L., Carr, J. E., Patel, M. R., & Enloe, K. A. (2000). Functional analysis of hair manipulation: A replication and extension. *Behavioral Interventions, 15*, 121–133.

Rapp, J. T., Miltenberger, R. G., Galensky, T. L., Ellingson, S. A., & Long, E. S. (1999). A functional analysis of hair pulling. *Journal of Applied Behavior Analysis, 32*, 329–337.

Rapp, J. T., Miltenberger, R. G., Galensky, T. L., Roberts, J., & Ellingson. (1999). Brief functional analysis and simplified habit reversal treatment of thumb sucking in fraternal twin brothers. *Child & Family Behavior Therapy, 21*(2), 1–17.

Rapp, J. T., Miltenberger, R. G., & Long, E. S. (1998). Augmenting simplified habit reversal with an awareness enhancement device: Preliminary findings. *Journal of Applied Behavior Analysis, 31*, 665–668.

Romaniuk, C., Miltenberger, R., & Deaver, C. (2003). Long term maintenance following habit reversal and adjunct treatment for trichotillomania. *Child & Family Behavior Therapy, 25*(2), 45–59.

Snorrason, I., & Woods, D. W. (2014). Hair pulling, skin picking, and other body-focused repetitive behaviors. In E. A. Storch & D. McKay (Eds.), *Obsessive-compulsive disorder and its spectrum: A life-span approach* (pp. 163–184). Washington, DC: American Psychological Association.

Spieler, C., & Miltenberger, R. (2017). Using awareness training to decrease nervous habits during public speaking. *Journal of Applied Behavior Analysis, 50*, 38–47.

Stanley, M. A., Borden, J. W., Mouton, S. G., & Breckenridge, J. K. (1995). Nonclinical hair pulling: Phenomenology and related psychopathology. *Journal of Anxiety Disorders, 8*, 119–130.

Stricker, J. M., Miltenberger, R. G., Garlinghouse, M., & Tulloch, H. E. (2003). Augmenting stimulus intensity with an awareness enhancement device in the treatment of finger sucking. *Education and Treatment of Children, 26*, 22–29.

Stricker, J. M., Miltenberger, R. G., Garlinghouse, M. A., Deaver, C. M., & Anderson, C. A. (2001). Evaluation of an awareness enhancement device for the treatment of thumb sucking in children. *Journal of Applied Behavior Analysis, 34*, 77–80.

Tarnowski, K., Rosen, L., McGrath, M., & Drabman, R. (1987). A modified habit reversal procedure in a recalcitrant case of trichotillomania. *Journal of Behavior Therapy and Experimental Psychiatry, 18*, 157–163.

Teng, E., Woods, D., & Twohig, M. (2006). Habit reversal as a treatment for chronic skin picking. *Behavior Modification, 30*, 411–422.

Teng, E., Woods, D., Twohig, M., & Marcks, B. (2002). Body-focused repetitive behavior problems: Prevalence in a nonreferred population and differences in perceived somatic activity. *Behavior Modification, 26*, 340–360.

Tolin, D., Franklin, M., Diefenbach, G., Anderson, E., & Meunier, S. (2007). Pediatric trichotillomania: Descriptive psychopathology and an open trial of cognitive behavioral therapy. *Cognitive Behaviour Therapy, 36*, 129–144.

Twohig, M., & Woods, D. (2001). Habit reversal as a treatment for chronic skin picking in typically developing adult male siblings. *Journal of Applied Behavior Analysis, 34*, 217–220.

Twohig, M., Woods, D., Marcks, B., & Teng, E. (2003). Evaluating the efficacy of habit reversal: Comparison with a placebo control. *Journal of Clinical Psychiatry, 64*, 40–48.

Wiskow, K. M., & Klatt, K. P. (2013). The effects of awareness training on tics in a young boy with Tourette syndrome, Asperger syndrome, and attention deficit hyperactivity disorder. *Journal of Applied Behavior Analysis, 46*, 695–698.

Woods, D., & Miltenberger, R. (Eds.). (2001). *Tic disorders, trichotillomania, and other repetitive behavior disorders: Behavioral approaches to analysis and treatment*. New York: Springer.

Woods, D., Miltenberger, R., & Flach, A. (1996). Habits, tics, and stuttering: Prevalence and relation to anxiety and somatic awareness. *Behavior Modification, 20*, 216–225.

Woods, D., & Twohig, M. (2001). Habit reversal treatment manual for oral-digital habits. In D. W. Woods & R. G. Miltenberger (Eds.), *Tic disorders, trichotillomania, and other repetitive behavior disorders: Behavioral approaches to analysis and treatment* (pp. 241–268). New York: Springer.

Woods, D., Wetterneck, C., & Flessner, C. (2006). A controlled evaluation of acceptance and commitment therapy plus habit reversal for trichotillomania. *Behaviour Research and Therapy, 44*, 639–656.

Woods, D. W., & Miltenberger, R. G. (1995). Habit reversal: A review of applications and variations. *Journal of Behavior Therapy and Experimental Psychiatry, 26*, 123–131.

Woods, D. W., & Miltenberger, R. G. (1996). Are persons with nervous habits nervous? A preliminary examination of habit function in a nonreferred population. *Journal of Applied Behavior Analysis, 29*, 259–261.

Woods, D. W., Miltenberger, R. G., & Lumley, V. A. (1996). Sequential application of major habit-reversal components to treat motor tics in children. *Journal of Applied Behavior Analysis, 29*, 483–493.

Wright, K. M., & Miltenberger, R. G. (1987). Awareness training in the treatment of head and facial tics. *Journal of Behavior Therapy and Experimental Psychiatry, 18*, 269–274.

Chapter 10
Breaking Habits Using Implementation Intentions

Marieke A. Adriaanse and Aukje Verhoeven

A substantial part of our daily behaviour is habitual (Wood, Quinn, & Kashy, 2002), including behaviours that we would rather not perform. For example, think about the cookie you routinely eat with your 11 o'clock coffee, or the bag of crisps that you mindlessly reach for while watching TV. Habits develop as people repeatedly perform a specific behaviour (e.g. reaching for the crisps) in a stable situation (e.g. watching TV) to pursue their goals, until eventually, the behaviour follows *automatically* upon encountering this situation (Aarts & Dijksterhuis, 2000; Verplanken, 2006). Although habit formation allows individuals to perform their daily routines in a very efficient manner, they can become problematic when intentions change, such as when someone with the habit of eating crisps when watching TV wants to restrict his/her caloric intake. Even though this person may be highly motivated to eat fewer high calorie crisps, in case of strong habits, and thus a strong association between the situation (watching TV) and the behaviour (reaching for the crisps), motivational factors are unlikely to overrule the automatic tendency to reach for the crisps when watching television. If the habit is sufficiently strong, chances are thus high that one will find oneself sitting in front of the TV, emptying a bag of crisps regardless of one's good intentions to diet. Indeed, many of us will agree that successfully changing 'bad' habits, such as the one described above, is difficult and may at times even feel impossible to realize, despite strong intentions to do so. It is therefore not surprising that psychologists have tried to identify strategies that can support people in changing their habits once they are no longer adaptive or wanted. One of the strategies that has received particular attention in the literature, and that will be the topic of this chapter, is the formation of 'implementation intentions' (specific if–then action plans; Gollwitzer, 1993, 1999).

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In this chapter we start out by introducing implementation intentions as a self-regulation strategy designed to help people acting in line with their good intentions. We will then move to the use of this strategy in relation to breaking habits specifically. We will discuss several studies that have tested the effectiveness of implementation intentions as a tool for overcoming bad habits across various domains. In addition, we will attempt to provide more insight into the processes by which this self-regulation strategy operates to compete with unwanted habits. We will then continue by highlighting some of the challenges and requirements for an effective use of this strategy when applying it in the real world. Finally, we will discuss additional techniques that could be combined with implementation intentions to enhance their effectiveness when it comes to changing complex habitual behaviours. In this chapter, we discuss the potential of implementation intention on overcoming unwanted habits in general, but readers may notice that we devote particular attention to habits in the domain of eating. Unhealthy eating behaviour is largely predicted by habits (Tricomi, Balleine, & O'Doherty, 2009; van't Riet, Sijtsema, Dagevos, & De Bruijn, 2011; Verhoeven, Adriaanse, Evers, & de Ridder, 2012), but also a behaviour that people frequently seek to change, making it a prototypical dilemma between good intentions on the one hand and unwanted habits on the other hand, which is why unhealthy eating habits have received considerable attention in implementation intention research (Adriaanse, Vinkers, De Ridder, Hox, & De Wit, 2011; Vilà, Carrero, & Redondo, 2017).

Implementation Intentions

Implementation intentions are specific action plans that specify where, when and how one will act to achieve one's goal. They were designed as a volitional strategy to promote the translation of intentions into actions, and to overcome the so-called intention–behaviour gap (Webb & Sheeran, 2006). Implementation intentions support the enactment of one's goal intentions by linking a specific good opportunity to act (where, when) to a pre-selected goal-directed action (how) using an if–then format. So, whereas goal intentions describe a desired end-state ('I intend to achieve Z!'), implementation intentions support the enactment of goal intentions by specifying a good opportunity to act (when, where) and linking this to a desired goal-directed action (how) in an if–then plan ('If I am in situation X, then I will perform goal-directed behaviour Y!;' Gollwitzer, 1993, 1999). For example, an individual with the goal to exercise more frequently ('I intend to exercise more often') may formulate the implementation intention 'If I come home from work, then I will put on my running shoes and go for a run' (Oettingen & Gollwitzer, 2010). By specifying a specific opportunity in advance, this situation becomes more cognitively accessible and individuals are more likely to recognize this situation as a good opportunity to act. Moreover, as a result of formulating implementation intentions an association between the specific situation and the desired behaviour response is created. After sufficient mental rehearsal of this if–then link, the situation becomes automatically linked to a specific behaviour with the result that one no longer has to decide in situ about which goal-directed behaviour to perform. Rather, when the specified situation ('coming home from work') is encountered, the behaviour ('putting one my running shoes') is now thought to be elicited automatically (Gollwitzer, 1999).

Support for these two underlying processes comes from work by Aarts and colleagues (Aarts, Dijksterhuis, & Midden, 1999) and work by Webb and Sheeran (2007). Aarts and colleagues provided evidence for the suggestion that by describing a specific situation in the if-part of the plan, this situation becomes highly salient with the result that the specified situation is detected quickly as a good opportunity to act. In their study, participants were assigned the goal to collect a coupon before the end of the study. They were informed where to collect this coupon (at the secretary's office in a small corridor, near a red fire-hose). They then either formed a relevant implementation intention (to collect the coupon) or an irrelevant action plan (to spend the coupon). Subsequently, the accessibility of the critical situation was tested. Using a computerized word-associations task (a lexical decision task), participants responded to words related to the critical situation (e.g. corridor, fire-hose). The results demonstrated that participants formulating a relevant plan (for collecting the coupon rather than spending it) were more successful in achieving their goal. This effect was found to be mediated by the accessibility of the specified situation: after relevant plan-formation, but not after forming an irrelevant plan, the situational cues became more cognitively accessible (i.e. participants responded to words that represented situational cues faster after forming a relevant implementation intention) and this increased accessibility in turn lead to a higher likelihood of successfully collecting the coupon.

Webb and Sheeran (2008) replicated this study, but also investigated the second proposed mechanism, which is the association that is created between the cue in the if-part of the plan, and the specified response in the then-part, that is thought to be responsible for automatically triggering this response upon encountering the specified situation. In a word-associations task similar to Aarts et al. (1999), they now not only assessed the accessibility of the situational cues, but also the strength of the association between the cues and the response (e.g. the 'corridor–collect' association). Results replicated the findings of Aarts et al. (1999), but also demonstrated that the effectiveness of implementation intentions is mediated by both (1) the accessibility of the specified situation as well as (2) the strength of the link between this situation and the desired response.

Implementation intentions can thus promote acting in line with one's goal intentions by making a pre-selected situation to act more accessible and by automatically triggering the planned response upon encountering this situation. In this sense, it could be said that implementation intentions, which have been referred to as 'instant habits' (e.g. Gollwitzer, 1999), mimic habits, as both are characterized by strong cue–response associations and their corresponding automaticity. The difference between habits and implementation intentions, however, is that the automatic behaviours that they produce stem from different processes. Whereas habitual cue–response associations have developed during a history of rewarded repetition, strong cue-response links resulting from implementation intentions are established through the process of deliberative planning (Gollwitzer, 2014). As a result, forming implementation intentions helps people to get started with their goal pursuit, to stay on track as implementation intentions shield ongoing goal-pursuit from other influences, and it helps performance of the behaviour while preserving mental capacity as the behaviour is triggered in a relatively automatic manner (Gollwitzer, 2014). Overall, the evidence for the effectiveness of implementation intentions in promoting goal-directed actions is compelling, and found across domains (e.g. consumer, prosocial, academic, health, environmental domain) with a meta-analysis (Gollwitzer & Sheeran, 2006) suggesting an overall medium to large effect on increased rate of goal attainment ($d = 0.65$). In addition, several domain specific meta-analyses have also yielded promising results with positive effects found for healthy eating (Adriaanse, Vinkers, et al., 2011; Vilà et al., 2017), exercise behaviour (Bélanger-Gravel, Godin, & Amireault, 2013; Carraro & Gaudreau, 2013) and improving prospective memory performance (Chen et al., 2015).

In sum, implementation intentions are specific action plans, typically formulated using an if–then structure, which describe a specific situation and link this to a desirable response. In this way, the described situation is easily detected and, upon encountering this cue, the specified response is activated automatically, thereby facilitating goal achievement. The mechanisms described above are relevant for implementation intentions in general. However, using implementation intentions to change existing habits is a more complicated matter. In the next section, we will discuss research on implementation intentions when they are designed to target existing habits.

Using Implementation Intentions to Break Unwanted Habits

Habits, both healthy and unhealthy, once started out as deliberate goal-directed actions. Over time, habits develop when an action is performed repeatedly under stable conditions in order to obtain a certain goal. Ultimately, a mental association is established between the context and the action. As a result, the action is triggered automatically when the specific context is encountered (Verplanken & Aarts, 1999). This automaticity entails that habits are performed efficiently, outside of our awareness, regardless of our intentions, and with little controllability (Bargh, 1994), which make habits in our daily lives adaptive, but also notoriously hard to control. Because of their automaticity, merely informing people, and motivating them to change their behaviour, is insufficient when it comes to bad habits, as such conscious processes do not amend the underlying cue–response associations that automatically trigger the unwanted response. Rather, behaviour change strategies targeting habitual behaviours ought to target the underlying cue–response associations.

Seeing that habits and implementation intentions appear to instigate similar automatic cue–response associations that only differ in origin; that is whether they are the result of repeated action (i.e. habits) or reflect conscious planning (i.e. implementation intentions), several studies have explored whether, in addition to promoting the execution of new, desired behaviours, implementation intentions may also be used to decrease existing unwanted habits. These studies are based on the assumption that people who are familiar with their 'situation-behaviour profile' (i.e. they know which cue elicits the unwanted habitual response; Gollwitzer & Sheeran, 2006) could formulate implementation intentions that are tailored to these critical cues. That is, implementation intentions could specify a new, desired behaviour to enact when encountering the critical cue that previously triggered the habitual, unwanted response (Adriaanse, De Ridder, & De Wit, 2009; Gollwitzer, 1999; Gollwitzer & Sheeran, 2006; Holland, Aarts, & Langendam, 2006) in order to create a new association that directly competes with the existing habit (but note that other formats of counterhabitual implementation intentions are also possible, such as implementation intentions specifying to ignore the critical cue, see below). For example, if a person wants to eat more healthily and is aware that s/he always eats crisps when watching television, this knowledge could be used to link the critical cue ('watching television') to a new, desired response (e.g. 'eating an apple'), resulting in the following implementation intention: 'If I am watching television and I want to eat something, then I will reach for the fruit bowl and take an apple'.

Taking a 'horse race' perspective on action control, whether or not the unwanted habitual behaviour or the newly planned behaviour would be executed upon encountering the critical cue would depend on the relative strength of the newly formed cue-goal directed response (e.g. TV-apple) and the habitual cue–unwanted behaviour (e.g., TV-crisps) associations (Adriaanse, Gollwitzer, de Ridder, de Wit, & Kroese, 2011). Provided that the cue-action link that is formed by the implementation intention is stronger than the habitual if–then pattern, the action stipulated in the implementation intention should theoretically overrule the habitual response. Below we will describe several studies across various domains that have adopted this approach to formulating counter-habitual implementation intentions. Please note that this is not an exhaustive overview of all of the relevant studies, but rather an illustration of the various applications of implementation intentions in relation to changing unwanted habits.

Empirical Evidence for Implementation Intentions Targeting Unwanted Habits

One of the first studies that tested this approach to breaking habits by formulating counter habitual implementation intentions was conducted by Holland and colleagues in a study on recycling habits (Holland et al., 2006). The results of this study were promising as they found that the formation of implementation intentions resulted in diminishing the old habit of throwing plastic cups and wastepaper into the bin and in promoting the new behaviour of recycling these items. Similarly, in the domain of eating, Adriaanse et al. (2009) tested whether implementation intentions that specify a cue that is habitually related to unhealthy snack intake, and then link this cue to an alternative healthy snack, could diminish the intake of unhealthy snacks. Results showed that, providing that participants specified the right critical cue, implementation intentions were indeed effective in reducing unhealthy snack intake by approximately 90 kilocalories a day and substituting this for healthy snacks.

Several studies also applied implementation intentions to the breaking of smoking habits. Armitage (2016), for example, investigated whether implementation intentions formulated with the aid of a 'volitional help sheet' (a sheet including a list of critical situations that may trigger the unwanted behaviour as well as a list with useful alternative responses; Armitage, 2008) could decrease habitual cigarette smoking. Results revealed that forming implementation intentions decreased habitual cigarette smoking, as measured by the Self-Report Behavioural Automaticity Index (SRBAI; Gardner, Abraham, Lally, & De Bruijn, 2012) as well as the average number of cigarettes smoked at follow-up 1 month later. Importantly, the effects of implementation intentions on behaviour change were found to be mediated by changes in habits, which makes this one of the most convincing studies demonstrating that implementation intentions can truly aid in breaking existing habits. Of note, however, is a study by Webb and colleagues (Webb, Sheeran, & Luszczynska, 2009) who found that although implementation intentions could be effective in reducing smoking behaviour, this was only true for people with weak or moderately strong smoking habits. These findings could be interpreted as evidence for the horse race perspective on action control as they suggested that, implementation intentions may be effective in diminishing unwanted habitual behaviours, but only to the extent that the new association formed by the implementation intention is stronger than the original habitual cue–response association. Obviously, this becomes more difficult, the stronger the habit that the implementation intention has to compete with.

Brewster, Elliott, and Kelly (2015) investigated the effectiveness of implementation intentions on a different behaviour that is generally considered to be habitual, which is that of speeding. They found that, amongst the 'inclined abstainers' (i.e. those participants who indicated to speed more often than they intended to), implementation intentions formulated with the use of a volitional help sheet were effective in reducing self-reported exceeding of the speed limit as compared to a control group that received general information about the risks of speeding. Providing further evidence for the notion that implementation intentions reduced speeding by weakening the habit, it was found that the formation of implementation intentions weakened the past-subsequent speeding behaviour link. Conversely, as a result of formulating implementation intentions the intention–subsequent speeding behaviour association was strengthened.

Other automatic tendencies that have been augmented using implementation intentions are stereotypes and emotional responses. Specifically implementation intentions have been found to aid in reducing automatic stereotypical thoughts (Stewart & Payne, 2008) as well as the actual behavioural expression of implicit stereotypes (Mendoza, Gollwitzer, & Amodio, 2010). In terms of automatic emotional responses, implementation intentions have been found to be effective in reducing spider fear in spider phobics (Schweiger Gallo & Gollwitzer, 2007; Schweiger Gallo, Keil, McCulloch, Rockstroh, & Gollwitzer, 2009) as well as in reducing prompted disgust reactions (Schweiger Gallo et al., 2009). Other examples of automatic effects that have been found amendable by the use of implementation intentions are switch costs in a task-switching paradigm as well as the automatic effects of spatial location in a Simon task (Cohen, Bayer, Jaudas, & Gollwitzer, 2008).

Underlying Mechanisms of Implementation Intentions Targeting Unwanted Habits

The studies outlined above demonstrate that implementation intentions can be effective in overruling various habitual behaviours. Although some evidence was also reported to demonstrate that effects on behaviour were mediated by changes in automaticity (in the context of smoking; Armitage, 2016) and that implementation intentions weakened the past-subsequent behaviour link (in the context of speeding; Brewster et al., 2015), still the studies discussed above do not provide much insight into the cognitive underpinning that make counter-habitual implementation intentions effective tools in overruling habits. That is, these studies do not provide insight into the effects on the cue-response associations that the implementation intentions were designed to target. Adriaanse and colleagues (2011) designed a study to fill this gap in the literature and to tap into these cognitive underpinning. Specifically, building on Kruglanski et al. (2002) goal systems theory, they hypothesized that the formation of a counter-habitual implementation intention strengthens the association between the critical cue and the alternative response, and simultaneously inhibits the association between the critical cue and the habitual response, and that the combination of these effects cancel out the advantage of the habitual over the alternative means in winning the race.

To test their hypotheses, Adriaanse, Gollwitzer, et al. (2011) conducted a computerized word association task (a lexical decision task) in which participants were asked to respond as quickly and accurately as possible to letter strings appearing on the screen according to whether they represented an existing word or a non-word. Before taking the lexical decision task, all participants had formulated the goal-intention to eat fewer unhealthy snacks. Half of the participants then augmented this goal-intention by an implementation intention linking a personal critical cue to a personally selected alternative snack. The lexical decision task that followed included words that represented participants' habitual unhealthy snacks as well as their personally selected healthy alternative snack. To test their hypotheses, reaction times for recognizing the habitual snack and the alternative snack as words, after first being exposed (primed) with their personally provided critical cue, were compared between participants in the goal intention and goal intention + implementation intention conditions. So, in this paradigm, the reaction times to the habitual snack after first being exposed to the critical cue reflects the strength of the habit, whereas the reaction time to the alternative snack after being exposed to the critical cue reflects the new, planned association.

Results of three studies were in line with the authors' expectations. Counter-habitual implementation intentions that specified the replacement of a habitual response by an alternative response in a critical situation indeed increased the strength of the mental link between the cue and the alternative response, and reduced the strength of the mental link between the same cue and the habitual response. The implementation intentions, however, did not immediately replace the old habit by a new habit, as in the most critical test of their hypotheses (Study 3), the alternative and habitual response were equally strongly related to the critical situation. From their findings, the authors concluded that implementation intentions are effective in overcoming unwanted habits, as they allow individuals to return to the type of action control—guided by our conscious intentions—that existed before any habit was created in the first place. In other words, after formulating the counter-habitual implementation intention the old habitual and the new alternative response are now again truly competitive in winning the horse race for activation when encountering the critical cue. These findings suggest that although having good intentions may not be sufficient when behaviour change involves breaking existing habits, it is a necessary first step towards success, at least when using implementation intentions. This suggestion also aligns with the general literature on implementation intentions which has demonstrated numerous times that implementation intentions are effective only when they are supported by strong goal-intentions (Sheeran, Webb, & Gollwitzer, 2005).

Other Types of Counter-Habitual Implementation Intentions

It is important to point out that the studies discussed above studied one specific type of counter-habitual implementation intention, whereas several variants of implementation intentions have been proposed to aid in the breaking of habits (Gollwitzer, Bayer, & McCulloch, 2005). That is, in addition to implementation intentions that specify the substitution of a habitual response with an alternative response, such as the ones described above ('If I am in critical situation X, then I will perform alternative behaviour Y!'), implementation intentions could also be formulated to specify the negation of the habitual response ('If I am in critical situation X, then I will not perform habitual behaviour Z!') or to ignore the critical cue associated with the habitual response ('If I am in critical situation X, then I will ignore X!'). Unfortunately, implementation intentions using a negating format have proven to be ineffective in breaking habits (Adriaanse, Van Oosten, De Ridder, De Wit, & Evers, 2011; Otis & Pelletier, 2008; but for positive findings see Sullivan & Rothman, 2008), because they ironically strengthen rather than diminish the association between the cue and the unwanted response, in particular in case of strong habits

(Adriaanse, Van Oosten, et al., 2011). Yet, implementation intentions that specify an ignore-response do appear to be a good alternative. These 'ignore' implementation intentions have for example been found to help people to effectively deal with interfering inner states (i.e. cravings for junk food and disruptive thoughts, feelings, and physiological states; Achtziger, Gollwitzer, & Sheeran, 2008), to reduce implicit stereotyping (Mendoza et al., 2010), and to aid in down-regulating emotions, such as disgust and fear responses (Schweiger, Gallo et al., 2009).

Simple Plans in a Complex World

In sum, several studies reported compelling evidence for the effectiveness of implementation intentions for changing unwanted habit. Yet it should be noted that the effects on diminishing unwanted habits may be weaker than overall effects on promoting novel behaviours. For example, the meta-analysis of Adriaanse, Vinkers, et al. (2011) revealed that effects on increasing fruit and vegetable intake where notably stronger than on decreasing unhealthy food intake. Two more recent meta-analyses on this topic have yielded somewhat opposing results with a meta-analysis on fat intake by Vilà et al. (2017) yielding an overall moderate effect on reducing fat intake and another meta-analysis reporting small effects post-intervention and negligible effects at follow-up on food intake and no effect on weight change (Turton, Bruidegom, Cardi, Hirsch, & Treasure, 2016). Based on these latter findings, some experts on habit and habit change (e.g. Carden & Wood, 2018) have concluded that implementation intentions are not a particularly promising tool when trying to break habits, and that rather, we should focus on altering the environments that trigger the unwanted habits. Although this may certainly be a very effective approach to changing habits (e.g. Verplanken & Wood, 2006; Wood, Tam, & Witt, 2005), this is also a quite drastic approach which may not always be realistic, and at times even impossible. For example, we cannot always move or change jobs whenever we want to kick a bad habit, and several of the cues triggering our unwanted habits may simply be impossible to avoid (e.g. internal cues such as emotions or other inner states). So, we would argue that even if future studies would consistently suggest that implementation intentions yield only a small effect on altering habits, the fact that they can be considered a very minimally invasive intervention makes them an appealing strategy to apply, potentially alongside other interventions such as mental contrasting (Adriaanse et al., 2010; Stadler, Oettingen, & Gollwitzer, 2009), inhibitory control training or attentional bias modification (Turton et al., 2016).

Indeed, implementation intentions involve the formation of a single if–then plan, which means that they are convenient to use, applicable to a large range of behaviours, relatively cheap to implement, and impose little burden on participants (Hagger & Luszczynska, 2014) and therefore seem ideal to be used in large scale behaviour change interventions. Nonetheless, the usefulness and effectiveness of implementation intentions is limited under certain circumstances, especially when they are applied to change existing habits in real-life settings. Below we will highlight several of these circumstances and challenges, which may very well also explain the mixed evidence alluded to above. In addition to highlighting these challenges, we will attempt to make suggestions for potential solutions to deal with these challenges in order to formulate effective implementation intentions, even when behaviour change involves more complex behaviours or circumstances.

Requirements for Implementation Intentions in General

Formulating Precise If–Then Plans

The specificity of implementation intentions is thought to be crucial for its effectiveness, as targeting cues that are described more precisely, will be detected more easily. Also, describing more clear (rather than vague) cues and responses will leave little room for deliberation, which facilitates the elicitation of the desired action (De Vet, Oenema, & Brug, 2011; Gollwitzer, 1999). Although some researchers have found effects using more general plans specifying when, where and how to act, while others have been using strict instructions to formulate specific 'if…, then…' plans, two studies that have put the effectiveness of specific versus global plans to the test, however, demonstrate that the specific if–then format is more effective than global plans (Chapman, Armitage, & Norman, 2009; Oettingen, Hönig, & Gollwitzer, 2000). Therefore, using specific if–then plans seems advisable.

To promote the formulation of specific plans, researchers have compared the effect of implementation intentions that are *generated by professionals* (e.g. the experimenter or a therapist) with plans formulated by participants themselves. Implementation intentions are typically more effective when its formation is guided by a professional (Armitage, 2009; Ziegelmann, Lippke, & Schwarzer, 2006). Yet, having professionals generate tailored implementation intentions seriously threatens the applicability of this strategy. When aiming for large-scale behaviour change interventions, it is preferred to combine implementation intentions with other strategies that promote correct formulation, such as using a *volitional help sheet* (Armitage, 2008).

Ensuring High Motivation

Implementation intentions are described as being subordinate to goal intentions (Gollwitzer, 1993, 1999), meaning that a strong goal intention needs to be in place before implementation intentions can be effective. Research indeed demonstrates that implementation intentions' effectiveness depends on the strength of one's goal intention: the stronger one's goal intention is, the more effective action plans are (Sheeran et al., 2005). In addition, it has been found that implementation intentions are effective only when the instructions to make plans are provided in an autonomy supportive manner (Koestner et al., 2006) meaning that people should be intrinsically rather than extrinsically motivated to enact their plans in order for the plans to be effective. One strategy that may be particularly useful to boast overall goal commitment while simultaneously enhancing the personal relevance of the plan would be to augment the formation of implementation intentions with the use of mental contrasting (MCII), a strategy which we will discuss below.

Requirements for Implementation Intentions When Changing Habits

Finding the Critical Cue

Implementation intentions that aim to substitute an old habitual response for a planned alternative response are effective only to the extent that they specify the actual trigger of the unwanted behaviour. That is, for the implementation intention to be effective in substituting the unwanted behaviour, the planned response needs to directly compete with the unwanted automatic response, which means that the planned response needs to be linked to the critical cue that triggers the unwanted habitual response. An implementation intention specifying a cue that does not represent the actual trigger of the unwanted behaviour may be effective in adding a new wanted response to participants' behavioural repertoire, but they will not result in replacing an old behaviour (Adriaanse et al., 2009). Thus, unlike implementation intentions designed to promote new behaviours (e.g. to perform a breast self-exam, to increase vitamin C intake), for counter-habitual implementation intentions specifying *any* good opportunity to act is not sufficient, as for effectively breaking habits *the* critical cue triggering the unwanted behaviour needs to be specified. Unfortunately, this requirement makes the formation of effective counter-habitual implementation intentions considerably more difficult, as people generally have poor introspection into the reasons for their own behaviour (Nisbett & Wilson, 1977). In case of habits, introspection into the reasons for one's behaviour should be particularly problematic seeing that habitual behaviours are characterized by automaticity and unawareness (Verhoeven, Adriaanse, De Vet, Fennis, & De Ridder, 2014).

Identifying cues that trigger one's habits may thus be prone to error, and even more so when behaviour change involves a complex behaviour that may be triggered by a variety of subtle cues. Example of such complex behaviours are most health-risk behaviours, (e.g. unhealthy snacking, smoking, drinking) where critical cues may often be related to subjective internal states (e.g. boredom) rather than to more objective situational cues reflecting a specific time or place (Adriaanse et al., 2009). Indeed, in the domain of eating, it has been found that people may hold false beliefs about the causes of their eating, and may rely on (personally) popular, but inaccurate, beliefs that their unhealthy eating is triggered by negative emotions (Adriaanse, De Ridder, & Evers, 2011; Evers, De Ridder, & Adriaanse, 2009).

One strategy that might help the identification of critical cues is *cue-monitoring*, which has been used in relation to formulating counter-habitual implementation intentions in the domain of eating (Verhoeven et al., 2014). In cue-monitoring, people reflect on their critical situations in situ, using a diary. In the context of eating behaviour, this means that participants do not only reflect on their snack consumption, but also on the situation triggering the consumption, by monitoring their location, activity company, and feelings when they engage in unhealthy snacking. Moreover, participants are asked which aspect of the situation reflects their most important trigger for unhealthy snacking (such as feeling bored). As in cue-monitoring people reflect on their behaviour in situ, dependence on retrospective memory is limited. This strategy has been found to be effective in itself, but may also be used to inform the identification of critical cues for if–then plans (Verhoeven et al., 2014).

Another technique that may foster insight into critical cues is '*mental contrasting'* (Oettingen, 2012). Mental contrasting is a self-regulation strategy in which people first imagine the desirable future and subsequently think about the reality that prevents them from fulfilling their goals. By explicitly contrasting their future wishes with the present reality, people obtain a clearer picture of the obstacles that stand in their way and that they need to take action in order to achieve their desired future. This leads to heightened levels of (expectancy-dependent) commitment towards achieving one's selected goals. Interestingly, Adriaanse et al. (2010) report evidence suggesting that mental contrasting may also aid the identification of the cues driving the unwanted habits that people desire to overcome, and that combining implementation intentions with mental contrasting (MCII) enhanced implementation intention efficacy. This provides further evidence for the notion that the efficacy of implementation intention interventions in diminishing unwanted habits is dependent on whether people can accurately specify critical cues for their habitual behaviour. Moreover, these findings highlight the potential of supplementing the use of implementation intentions with strategies that foster identification of critical cues. Indeed, several studies have reported beneficial effects of MCII on various behaviours ranging from exercising (Sailer et al., 2015; Stadler et al., 2009) and eating (e.g. Loy, Wieber, Gollwitzer, & Oettingen, 2016; Stadler et al., 2009) to improving time management (Oettingen, Kappes, Guttenberg, & Gollwitzer, 2015).

Lastly, several studies have demonstrated that providing examples in the form of a *volitional help sheet* may be helpful (Armitage, 2008) and there is some tentative evidence that inducing a '*hot' state* (e.g. hunger) before asking participants to think about critical cues (De Ridder, Ouwehand, Stok, & Aarts, 2011) may be useful as well. This latter approach builds on the notion that people are generally in a 'cold' state when making plans and that people in a cold state tend to underestimate the influence of hot states (e.g. hunger, emotions) on their behaviour (Loewenstein, 1996). This could be problematic seeing that these hot states are plausible candidates to be critical cues for various unwanted habits, such as unwanted eating habits.

Strengthening the Link Between 'If' and 'Then'

The degree to which implementation intentions are effective when competing with existing habits is for a large part determined by the association that is created between the specified situation and response (Webb & Sheeran, 2007). Therefore, a strong if–then link is essential. Ways to strengthen the link between the cue and the response are, for example, to repeat the plan multiple times by writing, repeating in one's head or saying the plan out loud (Hagger et al., 2016). Another solution that is found effective is to apply mental imagery (Knäuper et al., 2011; Knäuper, Roseman, Johnson, & Krantz, 2009). *Mental imagery* is rehearsing the performance of the specific action in the targeted situation in mind. As mental imagery drives on rich multisensory processes, it is thought to be highly similar to the real experience. Therefore, mentally imagining the performance of the planned action in the specified context is supposed to mimic processes of rehearsal in the actual situation, thereby enhancing the accessibility of the targeted situation and strengthening the association that is developed between this situation and the desirable response (Knäuper et al., 2009, 2011). Hence, adding mental imagery is a relatively simple way to improve cue-accessibility and the strength of the if–then link, which in turn enhance plan effectiveness.

The Inflexibility of a Single If–Then Plan

Although implementation intentions' effectiveness is conditional on a strong and specific cue–response association, it may not always be practical to make a single, highly specific if–then plan when behaviour change involves targeting complex behaviours like, for example, eating. To start with, most unhealthy behavioural patterns are a result of multiple undesirable actions. For example, when it comes to eating, most people do not have a single bad habit, but eat unhealthily in response to a variety of cues (e.g. when feeling sad, when feeling bored, when watching TV, etc.; Cleobury & Tapper, 2014; Verhoeven, Adriaanse, de Vet, Fennis, & de Ridder, 2015). Formulating a single plan might address one of these cues, but one could wonder whether this is sufficient to change behaviour in a meaningful (e.g. clinically relevant) way. A seemingly logical approach in such cases, may be to formulate multiple plans each targeting a different critical cue for unhealthy snacking behaviour. Although this approach may sound intuitively appealing, it has been found that this may in fact be quite problematic as formulating multiple plans appears to jeopardize the effectiveness of implementation intentions (e.g. Verhoeven, Adriaanse, De Ridder, Vet, & Fennis, 2013).

Another problem related to formulating one specific plan when targeting habitual behaviours that people perform repeatedly during the day, involves the inflexibility of specifying one alternative behaviour. For example, when a person with the habit of eating crisps when watching TV formulates a plan to take an apple instead, this means that the effectiveness of the plan is dependent on the availability of this specific food item. In addition, although the repeated execution of the same behaviour may be conducive to the formation of a new habit, adopting the same alternative behaviour over and over again may not always be considered desirable. Indeed, people formulating implementation intentions to target daily habits may be tempted to specify multiple alternative responses rather than a single solution in the then-part of the plan. For example, when trying to account for the unavailability of apples, a solution would be to make a plan B ('If I am feeling bored and want to take a snack, then I will eat an apple, or else, I will eat a banana!'). However, similar to specifying multiple plans, formulating such a plan B, thereby linking a critical situation to multiple solutions has been found to reduce the effectiveness of implementation intentions (Vinkers, Adriaanse, Kroese, & de Ridder, 2015). A better approach to avoid problems related to specifying a fixed alternative, could in some situations, be to use implementation intentions that specify an ignore-response (e.g. 'If I am in critical situation X, then I will ignore X!'). These 'ignore' implementation intentions have for example been found applicable to internal cues, such as cravings or disruptive thoughts or feelings as well (Achtziger et al., 2008).

Another solution to the problems explained above would be to apply implementation intentions as a *metacognitive strategy* by explaining the strategy to participants to enable the independent use of if–then plans (Verhoeven, 2015). Preliminary research demonstrated that it might be possible to teach people how to formulate their own plan, which could be adapted over time to accommodate changing needs, without the interference of a professional or intervention tool. In this way implementation intentions are truly used as a self-regulatory strategy, without depending on a professional. More research is however needed to test the effectiveness of metacognitive strategies.

Staying Motivated with Minor Changes

Implementation intentions typically focus on relatively small changes in one's lifestyle. For example, when it comes to eating behaviour, studies using implementation intentions have resulted in a reduction of approximately 90–125 kcal (Adriaanse et al., 2009, 2010; Sullivan & Rothman, 2008). This reduction, that is equal to about two handful of crisps, is a meaningful change for people's health on a population level (Hill, Wyatt, Reed, & Peters, 2003). In addition, such small, significant adaptations likely promote sustainable behaviour change on the long run. Yet, for individual participants, this might be hard to recognize, as this does not result in drastic weight reduction, or even in noticeable differences when looking in the mirror, and the effects of implementation intentions might therefore not be perceived as rewarding. It might discourage people if they do not experience results directly from implementation intention interventions, especially when alternative strategies might be offered that do promise quick and vast results (e.g. fad diets). How to keep people motivated in implementation intention interventions is one issue that has not been addressed much in the current literature. This is surprising considering that implementation intentions' effectiveness relies not only on the strength of the underlying goal intention but also on the commitment to the plan itself (Gollwitzer & Oettingen, 2016), which may diminish if it is not perceived as rewarding or helpful. One solution would be to embed implementation intentions with strategies that are developed to keep motivation high, such as *motivational interviewing* (Rubak, Sandbaek, Lauritzen, & Christensen, 2005; Treasure, 2004). Other additions such as *booster sessions* (Chapman & Armitage, 2010), *text messaging* (Prestwich, Perugini, & Hurling, 2009), *or planning together with significant others* (e.g. 'dyadic planning';

Burkert, Knoll, Luszczynska, & Gralla, 2012), might also be helpful to keep motivation levels high.

Concluding Thoughts

In conclusion, while implementation intentions are highly promising tools for behaviour change in applied contexts, these simple plans might not be so straightforward to use when trying to compete with existing habits in a complex world. In their daily lives, people might encounter specific boundary conditions that limited the applicability of implementation intentions. For example, people typically have multiple habits related to an overarching goal, while based on the literature, people are advised to make a single plan only. Also, as implementation intentions' effectiveness involves making one strict and specific plan according to a specific format, implementation intentions are inherently inflexible. This inflexibility clearly contrasts the ever-changing environment we are living in. Future research should therefore investigate ways to promote the flexible adjustments of people's personal plan to accommodate changes in their needs. Finally, as implementation intentions result in relatively small changes in one's lifestyle, it is important to acknowledge that motivation might reduce over time in implementation intentions interventions, and ways of keeping up participants' motivation level are important to consider.

Habit Research in Action

This box provides guidelines to do implementation intention research, based on the existing literature and our own experience, to support researchers who aim to study implementation intentions.

Control condition

Using high-quality control conditions is important to prevent the overestimation of implementation intentions' effectiveness (Adriaanse, Vinkers, et al., 2011). Ideally, participants in the control condition receive an active control exercise that mimics the implementation intention condition as much as possible, except for the implementation intention-specific instructions. This means that if participants in the planning conditions are asked to obtain a certain goal (e.g. 'try to eat fewer unhealthy snacks this week'), this should be communicated to the control participants too. Likewise, control conditions can be matched to receive a similar amount feedback, and spend a similar amount of time and effort on the exercise. Examples of control exercises are making a list of healthy options to eat more healthily (Adriaanse et al., 2009) or receiving tailored information (De Vries, Kremers, Smeets, Brug, & Eijmael, 2008), rather than merely receiving additional information or questionnaires.

Identifying the critical cue
When aiming to change habits, identification of the critical cue is essential, yet people generally have poor introspection into the triggers of their habits. Consider using additional strategies to promote identification of critical cues such as cue-monitoring (Verhoeven et al., 2014) or 'mental contrasting' (Oettingen, 2012) (see main text).

Instructions for plan-formation
It is not easy for participants to independently formulate correct implementation intentions. If possible, an experimenter could guide plan formation (Armitage, 2009; Ziegelmann et al., 2006). This is, however, not always possible or relevant (due to time/financial constraints or when testing for online interventions). To support formation of high quality plans, we use elaborate, step-by-step instructions, involving the following steps:

1. Ask participants to write down their single most important trigger for the targeted behaviour. If plan formation was preceded by a monitoring-period (e.g. cue-monitoring), encourage participants to think about the learnings from this phase.
2. Instruct participants to rewrite their personal trigger in one sentence starting with 'If…'.
3. Ask participants to write down one desirable, alternative response that could be performed instead. Examples could be provided. Participants should be instructed to always include an alternative (rather than making negating plans, e.g. planning to do nothing or to ignore the desire to perform the habitual action).
4. Prompt participants to rewrite their alternative in one sentence, starting with 'Then…'.
5. Ask participants to link the if-part and then-part to make the plan complete, by writing it down as one 'If…, then…' sentence.
6. To strengthen the if–then link, ask participants to repeat their plan by saying it out loud, writing it down once more, or vividly imagine enacting the plan (see Knäuper et al., 2009).

References

Aarts, H., & Dijksterhuis, A. (2000). Habits as knowledge structures: Automaticity in goal-directed behavior. *Journal of Personality and Social Psychology, 78*, 53–63.
Aarts, H., Dijksterhuis, A., & Midden, C. (1999). To plan or not to plan? Goal achievement or interrupting the performance of mundane behaviors. *European Journal of Social Psychology, 29*(8), 971–979.
Achtziger, A., Gollwitzer, P. M., & Sheeran, P. (2008). Implementation intentions and shielding goal striving from unwanted thoughts and feelings. *Personality and Social Psychology Bulletin, 34*, 381–393.

Adriaanse, M. A., de Ridder, D. T., & de Wit, J. B. (2009). Finding the critical cue: Implementation intentions to change one's diet work best when tailored to personally relevant reasons for unhealthy eating. *Personality & Social Psychology Bulletin, 35*, 60–71.

Adriaanse, M. A., De Ridder, D. T. D., & Evers, C. (2011). Emotional eating: Eating when emotional or emotional about eating? *Psychology and Health, 26*, 23–39.

Adriaanse, M. A., Gollwitzer, P. M., de Ridder, D. T. D., de Wit, J. B. F., & Kroese, F. M. (2011). Breaking habits with implementation intentions: A test of underlying processes. *Personality and Social Psychology Bulletin, 37*, 502–512.

Adriaanse, M. A., Oettingen, G., Gollwitzer, P. M., Hennes, E. P., De Ridder, D. T., & De Wit, J. B. (2010). When planning is not enough: Fighting unhealthy snacking habits by mental contrasting with implementation intentions (MCII). *European Journal of Social Psychology, 40*, 1277–1293.

Adriaanse, M. A., van Oosten, J. M., de Ridder, D. T., de Wit, J. B., & Evers, C. (2011). Planning what not to eat: Ironic effects of implementation intentions negating unhealthy habits. *Personality & Social Psychology Bulletin, 37*, 69–81.

Adriaanse, M. A., Vinkers, C. D., De Ridder, D. T., Hox, J. J., & De Wit, J. B. (2011). Do implementation intentions help to eat a healthy diet? A systematic review and meta-analysis of the empirical evidence. *Appetite, 56*, 183–193.

Armitage, C. J. (2008). A volitional help sheet to encourage smoking cessation: A randomized exploratory trial. *Health Psychology, 27*(5), 557.

Armitage, C. J. (2009). Effectiveness of experimenter-provided and self-generated implementation intentions to reduce alcohol consumption in a sample of the general population: A randomized exploratory trial. *Health Psychology, 28*, 545.

Armitage, C. J. (2016). Evidence that implementation intentions can overcome the effects of smoking habits. *Health Psychology, 35*, 935.

Bargh, J. A. (1994). The four horsemen of automaticity: Awareness, efficiency, intention, and control in social cognition. In R. S. Wyer Jr. & T. K. Srull (Eds.), *Handbook of social cognition* (2nd ed., pp. 1–40). Hillsdale, NJ: Erlbaum.

Bélanger-Gravel, A., Godin, G., & Amireault, S. (2013). A meta-analytic review of the effect of implementation intentions on physical activity. *Health Psychology Review, 7*, 23–54.

Brewster, S., Elliott, M., & Kelly, S. (2015). Evidence that implementation intentions reduce drivers' speeding behavior: Testing a new intervention to change driver behavior. *Accident Analysis and Prevention, 74*, 229–242.

Burkert, S., Knoll, N., Luszczynska, A., & Gralla, O. (2012). The interplay of dyadic and individual planning of pelvic-floor exercise in prostate-cancer patients following radical prostatectomy. *Journal of Behavioral Medicine, 35*, 305–317.

Carden, L., & Wood, W. (2018). Habit formation and change. *Current Opinion in Behavioral Sciences, 20*, 117–122.

Carraro, N., & Gaudreau, P. (2013). Spontaneous and experimentally induced action planning and coping planning for physical activity: A meta-analysis. *Psychology of Sport and Exercise, 14*, 228–248.

Chapman, J., & Armitage, C. J. (2010). Evidence that boosters augment the long-term impact of implementation intentions on fruit and vegetable intake. *Psychology and Health, 25*, 365–381.

Chapman, J., Armitage, C. J., & Norman, P. (2009). Comparing implementation intention interventions in relation to young adults' intake of fruit and vegetables. *Psychology and Health, 24*(3), 317–332.

Chen, X.-J., Wang, Y., Liu, L.-L., Cui, J.-F., Gan, M.-Y., Shum, D. H. K., et al. (2015). The effect of implementation intention on prospective memory: A systematic and meta-analytic review. *Psychiatry Research, 226*, 14–22.

Cleobury, L., & Tapper, K. (2014). Reasons for eating 'unhealthy' snacks in overweight and obese males and females. *Journal of Human Nutrition and Dietetics, 27*(4), 333–341.

Cohen, A. L., Bayer, U. C., Jaudas, A., & Gollwitzer, P. M. (2008). Self-regulatory strategy and executive control: Implementation intentions modulate task switching and Simon task performance. *Psychological Research, 72*, 12–26.

De Ridder, D. T. D., Ouwehand, C., Stok, F. M., & Aarts, F. (2011). Hot or not: Visceral influences on coping planning for weight loss attempts. *Psychology & Health, 26*, 501–516.
De Vet, E., Oenema, A., & Brug, J. (2011). More or better: Do the number and specificity of implementation intentions matter in increasing physical activity? *Psychology of Sport and Exercise, 12*, 471–477.
De Vries, H., Kremers, S. P. J., Smeets, T., Brug, J., & Eijmael, K. (2008). The effectiveness of tailored feedback and action plans in an intervention addressing multiple health behaviors. *American Journal of Health Promotion, 22*, 417–425.
Evers, C., De Ridder, D. T. D., & Adriaanse, M. A. (2009). Assessing yourself as an emotional eater: Mission impossible? *Health Psychology, 28*, 717.
Gardner, B., Abraham, C., Lally, P., & de Bruijn, G. J. (2012). Towards parsimony in habit measurement: Testing the convergent and predictive validity of an automaticity subscale of the self-report habit index. *International Journal of Behavioral Nutrition and Physical Activity, 9*, 102.
Gollwitzer, P. M. (1993). Goal achievement: The role of intentions. *European Review of Social Psychology, 4*, 141–185.
Gollwitzer, P. M. (1999). Implementation intentions: Strong effects of simple plans. *American Psychologist, 54*, 493.
Gollwitzer, P. M. (2014). Weakness of the will: Is a quick fix possible? *Motivation and Emotion, 38*, 305–322.
Gollwitzer, P. M., Bayer, U. C., & McCulloch, K. C. (2005). The control of the unwanted. In R. R. Hassin, J. S. Uleman, & J. A. Bargh (Eds.), *The new unconscious* (pp. 485–516). Oxford: Oxford University Press.
Gollwitzer, P. M., & Oettingen, G. (2016). Planning promotes goal striving. In K. D. Vohs & R. F. Baumeister (Eds.), *Handbook of self-regulation: Research, theory, and applications* (3rd ed., pp. 223–244). New York: Guilford.
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.
Hagger, M. S., & Luszczynska, A. (2014). Implementation intention and action planning interventions in health contexts: State of the research and proposals for the way forward. *Applied Psychology: Health and Well-Being, 6*, 1–47.
Hagger, M. S., Luszczynska, A., de Wit, J., Benyamini, Y., Burkert, S., Chamberland, P., et al. (2016). Implementation intention and planning interventions in health psychology: Recommendations from the synergy expert group for research and practice. *Psychology & Health, 31*(7), 814–839.
Hill, J. O., Wyatt, H. R., Reed, G. W., & Peters, J. C. (2003). Obesity and the environment: Where do we go from here? *Science, 299*, 853–855.
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.
Knäuper, B., McCollam, A., Rosen-Brown, A., Lacaille, J., Kelso, E., & Roseman, M. (2011). Fruitful plans: Adding targeted mental imagery to implementation intentions increases fruit consumption. *Psychology and Health, 26*, 601–617.
Knäuper, B., Roseman, M., Johnson, P. J., & Krantz, L. H. (2009). Using mental imagery to enhance the effectiveness of implementation intentions. *Current Psychology, 28*(3), 181–186.
Koestner, R., Horberg, E. J., Gaudreau, P., Powers, T., Di Dio, P., Bryan, C., et al. (2006). Bolstering implementation plans for the long haul: The benefits of simultaneously boosting self-concordance or self-efficacy. *Personality and Social Psychological Bulletin, 32*, 1547–1558.
Kruglanski, A. W., Shah, J. Y., Fishbach, A., Friedman, R. S., Chun, W. Y., & Sleeth-Keppler, D. (2002). A theory of goal systems: Implications for social cognition, affect, and action. In M. Zanna (Ed.), *Advances in experimental social psychology* (Vol. 34, pp. 331–376). New York: Academic Press.
Loewenstein, G. (1996). Out of control: Visceral influences on behavior. *Organizational Behavior and Human Decision Processes, 65*, 272–292.
Loy, L. S., Wieber, F., Gollwitzer, P. M., & Oettingen, G. (2016). Supporting sustainable food consumption: Mental contrasting with implementation intentions (MCII) aligns intentions and behavior. *Frontiers in Psychology, 7*, 607.

Mendoza, S. A., Gollwitzer, P. M., & Amodio, D. M. (2010). Reducing the expression of implicit stereotypes: Reflexive control through implementation intentions. *Personality and Social Psychology Bulletin, 36*, 512–523.

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

Oettingen, G. (2012). Future thought and behavior change. *European Review of Social Psychology, 23*, 1–63.

Oettingen, G., & Gollwitzer, P. M. (2010). Strategies of setting and implementing goals: Mental contrasting and implementation intentions. In J. E. Maddux & J. P. Tangney (Eds.), *Social psychological foundations of clinical psychology* (pp. 114–135). New York: Guilford.

Oettingen, G., Hönig, G., & Gollwitzer, P. M. (2000). Effective self-regulation of goal attainment. *International Journal of Educational Research, 33*(7), 705–732.

Oettingen, G., Kappes, H. B., Guttenberg, K. B., & Gollwitzer, P. M. (2015). Self-regulation of time management: Mental contrasting with implementation intentions. *European Journal of Social Psychology, 45*, 218–229.

Otis, N., & Pelletier, L. G. (2008). Women's regulation styles for eating behaviors and outcomes: The mediating role of approach and avoidance food planning. *Motivation and Emotion, 32*, 55–67.

Prestwich, A., Perugini, M., & Hurling, R. (2009). Can the effects of implementation intentions on exercise be enhanced using text messages? *Psychology and Health, 24*, 677–687.

Rubak, S., Sandbaek, A., Lauritzen, T., & Christensen, B. (2005). Motivational interviewing: A systematic review and meta-analysis. *The British Journal of General Practice, 55*, 305–312.

Sailer, P., Wieber, F., Pröpster, K., Stoewer, S., Nischk, D., Volk, F., et al. (2015). A brief intervention to improve exercising in patients with schizophrenia: A controlled pilot study with Mental Contrasting and Implementation Intentions (MCII). *BMC Psychiatry, 15*, 211.

Schweiger Gallo, I., & Gollwitzer, P. M. (2007). Implementation intentions: Control of fear despite cognitive load. *Psicothema, 19*, 280–285.

Schweiger Gallo, I., Keil, A., McCulloch, K. C., Rockstroh, B., & Gollwitzer, P. M. (2009). Strategic automation of emotion regulation. *Journal of Personality and Social Psychology, 96*, 11–31.

Sheeran, P., Webb, T. L., & Gollwitzer, P. M. (2005). The interplay between goal intentions and implementation intentions. *Personality and Social Psychology Bulletin, 31*, 87–98.

Stadler, G., Oettingen, G., & Gollwitzer, P. M. (2009). Effects of a self-regulation intervention on women's physical activity. *American Journal of Preventive Medicine, 36*, 29–34.

Stewart, B. D., & Payne, B. K. (2008). Bringing automatic stereotyping under control: Implementation intentions as efficient means of thought control. *Personality and Social Psychology Bulletin, 34*, 1332–1345.

Sullivan, H. W., & Rothman, A. J. (2008). When planning is needed: Implementation intentions and attainment of approach versus avoidance health goals. *Health Psychology, 27*, 438.

Treasure, J. (2004). Motivational interviewing. *Advances in Psychiatric Treatment, 10*, 331–337.

Tricomi, E., Balleine, B. W., & O'Doherty, J. P. (2009). A specific role for posterior dorsolateral striatum in human habit learning. *European Journal of Neuroscience, 29*, 2225–2232.

Turton, R., Bruidegom, K., Cardi, V., Hirsch, C. R., & Treasure, J. (2016). Novel methods to help develop healthier eating habits for eating and weight disorders: A systematic review and meta-analysis. *Neuroscience and Biobehavioral Reviews, 61*, 132–155.

Van't Riet, J., Sijtsema, S. J., Dagevos, H., & De Bruijn, G. (2011). The importance of habits in eating behavior. An overview and recommendations for future research. *Appetite, 57*(3), 585–596.

Verhoeven, A. A. (2015). *Facilitating food-related planning: Applying metacognition, cue-monitoring, and implementation intentions* (Doctoral Dissertation, Utrecht University).

Verhoeven, A. A., Adriaanse, M. A., De Ridder, D. T., Vet, E., & Fennis, B. M. (2013). Less is more: The effect of multiple implementation intentions targeting unhealthy snacking habits. *European Journal of Social Psychology, 43*(5), 344–354.

Verhoeven, A. A., Adriaanse, M. A., De Vet, E., Fennis, B. M., & De Ridder, D. T. (2014). Identifying the 'if' for 'if-then' plans: Combining implementation intentions with cue-monitoring targeting unhealthy snacking behavior. *Psychology & Health, 29*(12), 1476–1492.

Verhoeven, A. A., Adriaanse, M. A., De Vet, E., Fennis, B. M., & De Ridder, D. T. (2015). It's my party and I eat if I want to. Reasons for unhealthy snacking. *Appetite, 84*, 20–27.

Verhoeven, A. A., Adriaanse, M. A., Evers, C., & De Ridder, D. T. (2012). The power of habits: Unhealthy snacking behavior is primarily predicted by habit strength. *British Journal of Health Psychology, 17*, 758–770.

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? *European Review of Social Psychology, 10*, 101–134.

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

Vilà, I., Carrero, I., & Redondo, R. (2017). Reducing fat intake using implementation intentions: A meta-analytic review. *British Journal of Health Psychology, 22*(2), 281–294.

Vinkers, C. D., Adriaanse, M. A., Kroese, F. M., & de Ridder, D. T. (2015). Better sorry than safe: Making a plan B reduces effectiveness of implementation intentions in healthy eating goals. *Psychology & Health, 30*, 821–838.

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

Webb, T. L., & Sheeran, P. (2007). How do implementation intentions promote goal attainment? A test of component processes. *Journal of Experimental Social Psychology, 43*, 295–302.

Webb, T. L., & Sheeran, P. (2008). Mechanisms of implementation intention effects: The role of goal intentions, self-efficacy, and accessibility of plan components. *British Journal of Social Psychology, 47*, 373–395.

Webb, T. L., Sheeran, P., & Luszczynska, A. (2009). Planning to break unwanted habits: Habit strength moderates implementation intention effects on behaviour change. *British Journal of Social Psychology, 48*, 507–523.

Wood, W., Quinn, J. M., & Kashy, D. A. (2002). Habits in everyday life: Thought, emotion, and action. *Journal of Personality and Social Psychology, 83*, 1281.

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

Ziegelmann, J. P., Lippke, S., & Schwarzer, R. (2006). Adoption and maintenance of physical activity: Planning interventions in young, middle-aged, and older adults. *Psychology & Health, 21*, 145–163.

Chapter 11
Cracks in the Wall: Habit Discontinuities as Vehicles for Behaviour Change

Bas Verplanken, Deborah Roy, and Lorraine Whitmarsh

Introduction

Every December millions of people make New Year's resolutions. Newspapers, Internet, and social media are full of tips and recommendations. By the sixth of January millions of New Year's resolutions have gone down the drain. The idea behind these resolutions makes sense though: January first is a new beginning, a point where we can break with the past and begin a cleaner, healthier, or more prosperous future. While we may wish to change habits at other times in the year, in everyday life it is difficult to decide when exactly we should start doing that (e.g. Gollwitzer & Brandstätter, 1997). An event such as New Year may thus serve as an anchor point to hook on a habit change. What most people underestimate is the fact that life and our daily routines continue as usual after January 1st, activated by the same situational cues which maintain the old habit. We are, however, not only unaware of the power these conditions exert on our behaviour, but also grossly overestimate the willpower needed to overcome them.

Whereas a New Year's resolution may not be a very effective vehicle for habit change, the notion that 'moments of change', events that break existing patterns or routines, provide opportunities for more long-lasting change, seems plausible. There are many examples: 'catharsis' in psychotherapy paving the way for fundamental psychological changes, 'rites of passage' marking significant transitions in people's lives, improvement of safety regimes after natural or man-made disasters,

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or unexpected events turning the course of history. In this chapter we explore the idea that moments of change may be highly conducive to habit change. Although this is not a new idea, there is a growing interest for it in various fields, most notably transportation and health. Such transitions have been labeled 'entry points' (Axon, 2017), 'turning points' (Beige & Axhausen, 2012), 'fateful moments' (Giddens, 1991), 'transformative moments' (Hards, 2012), 'teachable moments', (Lawson & Flocke, 2009), 'moments of change' (e.g. Thompson et al., 2011), 'habit discontinuities' (Verplanken, Walker, Davis, & Jurasek, 2008), or 'context changes' (Verplanken & Wood, 2006). The suggestion is that these periods in people's personal, social, or professional circumstances provide opportunities for conscious, planned behaviour change (e.g. Schwanen, Banister, & Anable, 2012; Verplanken & Wood, 2006). In other words, interventions to change behaviour might be more effective—provide more value for money, if you will—if they capitalize on moments of change. We refer to this as the *Habit Discontinuity Hypothesis* (Verplanken et al., 2008; Verplanken & Wood, 2006).

Before we focus on change and habit discontinuities, we briefly outline a few basic concepts with respect to habit. As discussed in more detail elsewhere in this book, we consider a habit as an automatic association between a contextual cue and a response, which has a history of repetition and rewards (e.g. Rebar, Gardner, Rhodes, & Verplanken, 2018; Verplanken & Aarts, 1999; Wood & Rünger, 2016). Habits usually originate from deliberate goal-directed actions. Repeated and satisfactory execution of these actions creates representations of cue–response links in memory, which are automatically activated upon encountering the cue, thus triggering the habitual action. Habits thus indicate a significant role of the performance context in controlling behaviour, often greater than many of us realize. The original goal may trigger a habit (e.g. Aarts & Dijksterhuis, 2000), but goals need not necessarily be involved in habitual action, as contextual cues have assumed control. A goal may be activated if the action is thwarted or does not lead to the usual outcome, or if anything else changes in the context where the action is usually performed (e.g. Wood & Neal, 2007; Wood & Rünger, 2016). And the latter is the particular focus of the present chapter.

We will begin with a brief discussion about situations where behaviour changes due to changing circumstances. We then turn to studies that experimentally investigated the Habit Discontinuity Hypothesis, that is, designed interventions to explicitly capitalize on context change. In the final section, we discuss some mechanisms that may play key roles in these discontinuity effects.

Changing Circumstances, Changing Behaviour

Changing circumstances often imply changes in people's behaviours and habits. Changes may simply occur as a function of natural changes in our situation. That is, people adapt to changing circumstances without necessarily being motivated to change or having consciously planned any change in the first place (e.g. Clark, Chatterjee, & Melia, 2016; Fujii, Gärling, & Kitamura, 2001; Goodwin, 1989; Marsden & Docherty, 2013; Parkes, Jopson, & Marsden, 2016; Poortinga, Whitmarsh, & Suffolk, 2013). For instance, Parkes et al. (2016) investigated commuters' travel behaviours in the wake of the 2012 London Olympic and Paralympic Games. These games disrupted many commuters' travel habits. These researchers documented how commuters adapted to the situation by rerouting, retiming, or switching travel mode. Most of them reverted to the old patterns once the games were over. Of course, one may incidentally discover better options during such periods of disruption, which may lead to adopting new habits. That was the case for a portion of participants in a study of travel mode change during and after an eight-day freeway closure in Japan (Fujii et al., 2001). While many who commuted by car continued doing so after the closure was lifted, some who had switched to public transport during the closure discovered that they had overestimated the travel time by car and continued to use public transport after the disruption.

Behaviour change often co-occurs with important events in people's personal or professional lives (e.g. Beige & Axhausen, 2012; Marsden & Docherty, 2013; Scheiner, 2006; Scheiner & Holz-Rau, 2013; Thompson et al., 2011). While not an exhaustive list, some examples are transitions from school to work (e.g. Busch-Geertsema & Lanzendorf, 2017; Fujii & Gärling, 2003; Koehn, Gillison, Standage, & Bailey, 2016), family situation changes (e.g. Goodwin, 1989; Thomas, Fisher, Whitmarsh, Milfont, & Poortinga, 2017), residential relocation (Clark et al., 2016; Fatmi & Habib, 2017; Jones & Ogilvie, 2012; Scheiner, 2006; Thomas Poortinga, & Sautkina, 2016; Verplanken et al., 2008), changes in study, work or employment situations (e.g. Clark et al., 2016; Rogers, Vardaman, Allen, Muslin, & Brock Baskin, 2016; Walker, Thomas, & Verplanken, 2015; Wood, Tam, & Guerrero Witt, 2005), changes in retail contexts (e.g. Poortinga et al., 2013), new infrastructure (e.g. Heinen, Panter, Mackett, & Ogilvie, 2015), retirement (e.g. Barnett, van Sluijs, & Ogilvie, 2012; Burningham & Venn, 2017; Mein, Shipley, Hillsdon, Ellison, & Marmot, 2005; Midanik, Soghikian, Ransom, & Tekawa, 1995; Smeaton Barnes, & Vegeris, 2017), or surviving a life-threatening illness (Webb, Fife-Shaw, Ogden, & Foster, 2017). In such cases people adapt to the new circumstances or adopt behaviours that are typical, or believed necessary, in the new circumstances. Of course, while behaviours may thus change, this does not necessarily mean for the better. For instance, Koehn et al. (2016) documented how adolescents who transitioned from home to independence embraced new priorities, but certainly not a healthier lifestyle.

Whether people choose to change or adapt to changing circumstances, existing habits may or may no longer be useful or feasible, and if the latter, new behaviour has to be negotiated. A seminal study illustrating this process was conducted by Wood et al. (2005), who demonstrated the power of context and discontinuity effects in more detail. These researchers investigated what happened to students' habits (in this case exercising, reading the newspaper, and watching TV), when they transferred to a new university. While these are typically circumstances where a person enters a completely new environment, certain elements from the old environment may re-appear in the new one. For instance, the students in Wood et al.'s study were again living in a student house with one or more housemates. Two of the findings in that study were particularly significant for the present discussion. The first was that for some students the transfer led to a degree of ‘defreezing’ of old habits; their old routines were disrupted, and new behaviours emerged that were under the control of conscious intentions. Secondly, there were also students who continued to do what they did at their old university. These were students for whom the critical context cues that triggered their habits in the old situation were also present in their new location, such as ‘having a roommate who reads the newspaper’, which thus continued to trigger the old habit of reading the newspaper.

The first finding—intentions controlled behaviour in the new environment—means that when the context change involves the removal or disruption of contextual cues that trigger an old habit, the automatic responses to cues can no longer occur, and more deliberate processes kick in. Individuals may then be more open and attentive to new information, which otherwise would not be the case as habituation comes with ‘tunnel vision’, that is, a mindset in which the individual is almost immune to new information or alternative options (Verplanken, Aarts, & van Knippenberg, 1997). When a habit is blocked or suspended due to a change of context, this ‘spell’ is, at least temporarily, broken. The person may thus need and search information or advice, and be open to alternative options. This forms the basis of the Habit Discontinuity Hypothesis.

Equally important was Wood et al.’s (2005) second finding: those students who found the old cues recurring in the new context picked up and continued their old habits. This suggests that going through a context change does not necessarily mean a person will adopt new behaviours. As soon as the critical cues that triggered the habit in the old performance context re-appear in the new situation, the old habit is re-instated very quickly: the ‘sixth-of-January effect’. This demonstrates the power of context cues: the rewarding properties of habit contexts are enduring (e.g. Anderson & Yantis, 2013) and can be transferred to other performance contexts. Thus, all things being equal, while a discontinuity in the performance context may disrupt habits, the default tendency of people undergoing such changes is that old habits will re-appear if the original cues are still present after the disruption when the situation has stabilized (e.g. Fatmi & Habib, 2017; Fujii et al., 2001; Parkes et al., 2016).

Testing the Habit Discontinuity Hypothesis

While it is obvious that changing circumstances may lead to behaviour change, the key element of the Habit Discontinuity Hypothesis is that behaviour change *interventions* capitalize on those moments of change and thus be more effective compared to interventions delivered under stable conditions. We identified a number of studies that explicitly aimed at delivering a behaviour change intervention in the context of a life course change. These studies highlight several aspects that are important in understanding discontinuity effects.

Some studies focused on travel behaviours. Bamberg (2006) conducted a randomized controlled trial testing an intervention to promote the use of public transport in the German city of Stuttgart. Residents who had indicated they intended to move into the area within 6 months, were presented with a questionnaire at the start of the study and 12 weeks after they had moved house. They were randomly assigned to an intervention and control group. In the former condition an intervention was delivered 6 weeks after participants had moved house. The intervention consisted of personally tailored information about the local public transport facilities and a one-day free public transportation ticket. Compared to the control condition, participants who had received the intervention showed a stronger increase in the use of public transport. Thøgersen (2012) found similar effects in secondary data analyses studying the effect of a free travel pass on switching to public transport. Participants in that study had been randomly assigned to an experimental group, who received a one-month free travel pass, or to a control group. It was found that the intervention was only effective among participants who had moved house or workplace in the 3 months that preceded the study. Likewise, Ralph and Brown (2017) investigated the effect of a personalized transportation guide for traveling to the university, which was provided to a group of first year graduate students 2 months before the semester start. These were compared to a group of students who had not relocated. The results suggested that the transportation guide was effective for those who had moved house in the past 6 months, but not for those who had not relocated.

Two further studies focused on energy-related behaviours. Maréchal (2010) analyzed the proportion of energy subsidy applications to local authorities in the Brussels region in Belgium from residents who moved house in the previous 3 years versus incumbent residents. While there was no reason to suggest that those subsidies were more useful or available for residents who had relocated, they were more likely to apply for them than incumbent residents. In contrast to the focus of most studies on relocation as a habit-disrupting moment of change, one study considered electric vehicle purchase as a potential moment of change. Nicolson, Huebner, Shipworth, and Elam (2017) tested the Habit Discontinuity Hypothesis among a large sample of owners of electric vehicles who bought their vehicle up to 5 years ago. The owners of such cars were sent prompts to charge their vehicles during off-peak hours, which would contribute to reducing peak demand and thus the use of more polluting power plants. It was found that prompts were most effective (indicated by opening the email that was sent) if these were delivered within 3 months of the purchase of an electric car.

Verplanken and Roy (2016) conducted a randomized controlled field experiment that tested an intervention aimed at promoting a range of sustainable behaviours among households who had moved house in the previous 6 months. These participants were compared to a matched control group who had not relocated. Half of the participants in each group received an intervention while the other half served as the no-intervention control group. Self-reported behavioural frequency measures for 25 behaviours, averaged into an overall behavioural index, were taken at baseline and 8 weeks later. There were two main results. The first was that when the post-measure index of behaviour was regressed on the baseline measure, while controlling for major determinants of behaviour taken at baseline (i.e. the baseline behaviour index, habit strength, intention, perceived behavioural control, biospheric values, personal norms, and involvement), the intervention and, most importantly, the interaction of the intervention and moving status, were statistically significant: the intervention was effective among movers, but not among non-movers. Secondly, when we broke down moving status into more detail, the discontinuity effect appeared amongst those who had relocated in the past 3 months, whereas no effects were obtained for those who had moved more than 3 months earlier or had not moved at all.

Tests of the Habit Discontinuity Hypothesis have not always provided support for the hypothesis. Schäfer et al. (2012) tested the effects of two types of interventions (information mailing and personal consultation) on sustainable consumption as a function of two types of life course discontinuities (residential relocation and having a first child. While the consultation intervention was effective, this was not more the case after relocation or childbirth. On the contrary: the campaign appeared more effective in the stable life groups. Additional qualitative research suggested that a reason for this result might have been that the campaign was launched too late (6 months after the discontinuity moment), and was thus missing the 'window of opportunity', as new (unsustainable) routines had already been (re)established.

We can draw at least two conclusions from the intervention studies mentioned above. The first is that, taken together, the studies begin to provide good support for the Habit Discontinuity Hypothesis. Interventions do seem to be more effective when these are delivered in the context of major discontinuities, or when these are explicitly focused on such discontinuities. The second conclusion is that if one would wish to answer the question how long a 'window of opportunity' lasts, the evidence so far suggests that a period of approximately 3 months would probably be the best guess. Having said that, we need to be more precise about what exactly is meant by a 'window of opportunity', as this term has been applied widely to diverse endogenous (biographical, e.g. leaving home, starting a family) and exogenous (societal, e.g. energy shortages; new policies) events (Thompson et al., 2011). Also, a window may 'open' some time before the actual discontinuity materializes, for instance when people deliberate commuting options in considering new residential areas (Stanbridge & Lyons, 2006; Walker et al., 2015).

Some caveats need to be mentioned. First, studies vary in the rigor with which they test the Habit Discontinuity Hypothesis. The above studies compared the efficacy of an intervention between life course change and non-change groups, in order to isolate the effect of discontinuity. Only some of these randomized participants to intervention versus no-intervention conditions (Bamberg, 2006; Verplanken & Roy, 2016), while only one matched the discontinuity and no-discontinuity participants on key characteristics (Verplanken & Roy, 2016). Other studies instead examined interventions targeted to moments of change (e.g. parenthood, office relocation), but did not include a control group who received the intervention but were not undergoing a moment of change (Schulz et al., 2006; Walker et al., 2015). While those studies are unable to show the relative efficacy of interventions upon habit disruption, they nevertheless tell us something about habit breaking or formation. Some studies were able to investigate the length of the 'window of opportunity' (e.g. Nicolson et al., 2017; Verplanken & Roy, 2016). Obviously, each design characteristic has consequences for the validity of conclusions that can be drawn from a particular study. Also, the studies reviewed were all field studies investigating real-life discontinuities. While these contexts are of primary interest from an applied perspective, they do not allow rigorous testing such as controlled laboratory work might deliver, which makes it difficult to draw conclusions on, for instance, causality.

A second caveat is that a discontinuity may in fact be a proxy for other variables and conditions. For instance, 'moving house' may imply changing jobs, starting a family, or other circumstances and considerations, and may be embedded in a wider social, geographic, and cultural framework. This has led some authors to criticize the very concept of 'moments of change'. For instance, Burningham and Venn (2017) argued that '(…) transitions are often experienced as multiple, intersecting and in the context of relationships, and (…) always socially and materially situated' (p. 2). While acknowledging that 'moment of change' and 'windows of opportunity' imply more than the discontinuity moment itself, this does not make the Habit Discontinuity Hypothesis less meaningful.

Finally, it can be noted that, with the exception of Schulz et al.'s (2006) study of new parents, no other habit discontinuity studies documented longer-term effects. It is therefore impossible to draw conclusions on the longevity of habit discontinuity effects. Furthermore, little is known about mechanisms that underlie habit discontinuity effects. The latter, then, is the topic of the next section.

Unpacking the Habit Discontinuity Hypothesis

What exactly is a 'window of opportunity' created by a discontinuity in a person's life, and what may be the mechanisms driving habit discontinuity effects? We contend that potentially there are at least three processes involved in discontinuity effects: (1) 'unfreezing' old habits; (2) information acquisition and processing; (3) activating or changing goals or values. We will elaborate each of these three elements.

Unfreezing Old Habits: Kurt Lewin's Insights

Kurt Lewin was an influential scholar in the domain of social change, who published his major works in the late 1930s and 40s. Lewin is often cited as the originator of the 'unfreeze-change-freeze' model, which has become popular in the management literature, although it is often represented in overly simplistic terms (Cummings, Bridgman, & Brown, 2016). Lewin provided interesting analyses of change processes in the form of his Field Theory (e.g. Lewin, 1947). It should first be noted that Lewin's key unit of analysis was the social group, rather than the individual. In a Gestalt tradition, and being a true social psychologist, he considered the social group as encompassing more than the sum of individuals, and individual behaviours as a function of the group context. Lewin described a social system in terms of 'force fields', which refer to the total of influences toward or away from an outcome or criterion. Let us take as an example the degree to which a certain population behaves sustainably, and do things like saving water and energy, buy ecological and fair-trade products, and use public transport. This may thus be described as a field consisting of bundles of specific forces that encourage or discourage sustainable behaviours. These forces may include personal, social, and situational factors. Personal factors may for instance be individuals' expected costs and benefits of behaving sustainably or adhering to pro-environmental values. Social factors may consist of injunctive or descriptive norms encouraging or discouraging sustainable action, or activities of pressure groups. Situational factors may be physical, such as properties of the existing housing stock or poor public transport, but may also consist of events, such as an episode of flooding. All influences together, some exerting a positive and some a negative impact on aspiring sustainable lifestyles, thus form a force field, which is manifested as an overall level of sustainable living. It also exists, in Lewin's terms, as a quasi-stationary equilibrium: the degree of performing sustainable behaviours fluctuates around an average as long as specific forces do not substantially change or disappear, or new forces appear. An intervention to promote sustainable behaviour would be such a new force, and would thus lead to a new equilibrium of the force field, in this case, hopefully, at a higher level and thus an increase in sustainable behaviours. However, a habit (a 'historic constancy', in Lewin's terms) creates an additional force, which locks in behaviour and holds back change. This may occur, for instance, due to vested interests (e.g. the need to drive children to a distant school), existing infrastructure (e.g. unhelpful bus routes), or ingrained unsustainable social norms, values, or stereotypes (e.g. pro-environmental groups being seen as 'extremists'). If strong habits are prevalent, this would 'freeze' the system and prevent an intervention to move the equilibrium to a higher level. It thus follows that if existing habits were to be removed, or if something happened to make them ineffective ('unfreezing' the force field), the equilibrium would not be held back, and an intervention would be more successful, which is thus what discontinuities can be expected to accomplish.

Why do we elaborate on Kurt Lewin's field theory? Critics may say this is merely a description of the Habit Discontinuity Hypothesis using different terms. In addition, whereas Lewin's unit of analysis is at the level of the social group, the Habit Discontinuity Hypothesis was formulated at an individual level. We think Lewin's theory brings at least two important elements to the table. The first is that the concept of 'unfreezing' is also applicable at the individual level, i.e. (temporarily) breaking the cue–response links which we used to describe a habit (see also Chap. 10 in this volume). This has consequences such as the way individuals process information, make decisions and reorient themselves, which we will further discuss in the next section. Secondly, the Lewinian conception of habit as an element in a larger force field stresses the fact that habits are embedded and sustained by larger structures, which constitute the force field (e.g. Burningham & Venn, 2017; Guell, Panter, Jones,

& Ogilvie, 2012; Kurz, Gardner, Verplanken, & Abraham, 2015; Shove, Pantzar, & Watson, 2012). It follows that while a discontinuity in an individual's life may unfreeze a particular habit and thus make that individual more sensitive to change, an intervention that capitalizes on a *shared* discontinuity, thus including social, physical, geographical, and cultural elements, can be expected to be much more effective. Examples of such opportunities are new residential areas, major infrastructure disruptions, policies that restrict or remove choices (e.g. congestion charges; smoking ban), the restructuring or relocation of an organization, or the transitions of well-defined cohorts such as school leavers or retirees. In such cases, relatively large groups of people are undergoing a significant change in more or less the same time and space frames, which may make bespoke interventions feasible and cost-effective. In order to be effective, a 'Lewin-style' discontinuity intervention should then capitalize on a wide range of elements of that force field (e.g. expectations, attitudes, norms, interaction and communication patterns, infrastructure, financial support), or in popular management terms, adopt a 360° approach. Thus, if the larger force field is not implied in an intervention, even if it changes the behaviour of an individual, old habits are likely to be re-instated once the situation has stabilized, which is what the literature discussed earlier in this chapter suggests.

It does not only suffice to unfreeze a force field and move to a new, higher-level equilibrium; this new state should also be consolidated if the changes are to be maintained. In Lewin's (1947) words: '(…) after 'a shot in the arm', group life soon returns to the previous level' (p. 34). Hence, 'freezing' the new state and thus securing it against relapses should be a key objective if interventions are to be effective. This again concerns all relevant elements in the larger force field; the new equilibrium (in our example, a more sustainable lifestyle) must thus be supported not only by individual positive attitudes and intentions but also by social norms and standards, infrastructure, if possible socio-cultural changes, and last but not least new habits.

Information Acquisition and Processing

Discontinuities imply a 'shake-up' of one's everyday life behaviours and choices. By default, a significant proportion of those behaviours can be designated as habitual in nature (e.g. Wood, Quinn, & Kashy, 2002). A discontinuity thus creates a situation where a person has to reorient and make new choices. These new choices may be motivated by existing values or by a new set of priorities. In either case, the process of making a new choice will involve information acquisition and processing. In a research program on travel mode choices, Aarts and colleagues investigated the effects of habits on choices and decision-making in greater detail (Aarts Verplanken, & van Knippenberg, 1997, 1998; Verplanken et al., 1997). That work demonstrated that habitual and non-habitual behaviours differ markedly in terms of information acquisition and processing, and types of decision rules used to make choices. When strong habits are present individuals search or attend less to information which is relevant to their choices. This holds in particular for information about alternatives to habitual choices, as well as for the appreciation of the context of choices (Verplanken et al., 1997). Relatedly, strong habits are also associated with the use of non-compensatory compared to compensatory decision strategies (Aarts et al., 1997). The former strategies require less attention and fewer mental operations compared to the latter, and thus mirror the experience of doing things 'by force of habit' (Langer, Blank, & Chanowitz, 1978; Roy, Verplanken, & Griffin, 2015). Discontinuities require a reorientation based on available options and attributes, and may put individuals in a more deliberative mindset than they normally would have (e.g. Gollwitzer, Heckhausen, & Steller, 1990). If interventions capitalize on this, they may thus be more effective.

Value Activation or Change

Although many behaviours may originally have been guided by goals and values, these forces may disappear once behaviour has become habitual (e.g. Maio, 2017). For instance, in a study on the meaning of sustainability, participants who scored all high on environmental attitudes and values attributed unsustainable acts to 'thoughtless consuming' (Roy et al., 2015). It takes at least some form of cognitive activation, if not cognitive effort, to make people aware that an important value may be implicated in the behaviour at hand (e.g. Verplanken & Holland, 2002). A discontinuity and the associated need for a reorientation may do exactly that. Thus, a discontinuity may make individuals (re)consider long-term goals and motives in arriving at new choices and behaviours. In a study on sustainable commuting, Verplanken et al. (2008) measured university staff's environmental concern, and asked them also how they traveled to the university and when they last moved house. Not unexpectedly, the level of environmental concern correlated significantly with the degree to which they commuted by car versus other modes of transportation. However, when this was broken down by the time of relocation, the association only appeared to exist amongst those who had moved house in the past year. While this was a correlational study and can therefore not make causal claims, it supported the thesis that the relocation activated 'dormant' attitudes and values, which were then considered and acted upon (see for a conceptual replication, Thomas et al., 2016). For some, this may have been due to planning their relocation around availability of low-carbon travel options (Stanbridge & Lyons, 2006).

Some other studies provided evidence for the role of attitudes and values in discontinuity effects. Clark et al. (2016) analyzed the stability of commuting behaviours over the course of a year among a large UK sample. They found that employment changes and residential relocations were the major life events that made commuters switch, which primarily was driven by changes in distance to work. However, they also found that pro-environmental attitudes predicted switches from car to public transport or active commuting but not switches toward car commuting. Similarly, Matthies, Klöckner, and Preißner (2006) provided evidence that after an intervention to 'unfreeze' existing car use habits, the use of public transport was driven by perceived behavioural costs and by pro-environmental personal norms. Thomas et al. (2018) used a large longitudinal data set to analyze changes in pro-environmental behaviours as a function of having children. They found that whereas the general trend was toward behaving less sustainably, those who held pro-environmental attitudes showed a small increase in sustainable behaviours.

The process of 'unfreezing' habits thus not only interacts with the external social and physical context, as Lewin emphasized, but also with internal goals, priorities and values that motivate individuals. These internal motivations are more likely to manifest in consistent behaviour when external conditions are conducive (Stern, 2000). For example, environmental concern is more likely to predict recycling behaviour when one has a curbside recycling collection (Derksen & Gartrell, 1993). In relation to habit discontinuity, as the studies above suggest, contextual disruption may provide an opportunity for extant values to manifest in a new value-consistent behaviour.

New Year's resolutions may similarly act as a window of opportunity to change habits that have become 'misaligned' with one's goals or values (e.g. to be healthy). However, as discussed earlier, this desire to change is often insufficient to unfreeze old habits and freeze new ones. At this time, the use of 'implementation intentions' may help (e.g. Adriaanse, Gollwitzer, De Ridder, de Wit, & Kroese, 2011; see also Chap. 10 in this volume). This involves introducing a counter-response to an existing habitual act, accompanied by thoughtful consideration. Specifically, a concrete plan is formulated that aims to shift control over behaviour from contextual cues back to individual conscious deliberation (e.g. 'on Tuesday at 5pm, I will go to the gym'). This may result in new learning that the same goal can be achieved through more adaptive and favorable means. One still, of course, has the problem that existing contextual cues may be exerting control over current behaviours. However, with sufficient motivation, these new alternative responses could eventually become habitual in nature. Here, again, values may become manifest in value-consistent behaviour change.

In contrast to habit discontinuities that *activate* existing values, some may *change* an individual's values or result in a redefinition of the self-concept, for example when having a child (increasing nurturing and security values; Thomas et al., 2018), moving to a different culture (Bardi, Buchanan, Goodwin, Slabu, & Robinson, 2014), or overcoming addictions such as drugs, overeating, gambling, or smoking (e.g. Best et al., 2016; Epiphaniou & Ogden, 2010; Kearney & O'Sullivan, 2003; Kim, Wohl, Salmon, & Santesso, 2017; McBride, Emmons, & Lipkus, 2003). While overcoming addictions are beyond the scope of this chapter (but see Chaps. 17 and 18 in this volume), the role of the self and identity, both personal and social, is undoubtedly important in particular in making long-lasting changes in behaviours that do not have immediate personal benefits, such as in the ecological domain (e.g. Whitmarsh & O'Neill, 2010). Sociological and psychological studies both highlight that life transitions can act as moments of personal reflexivity and re-evaluation (Giddens, 1991; Williams, 1999). Interventions may capitalize on this change in values or identity by addressing multiple targets, either within the same domain (e.g. making a variety of environmentally friendly choices), or in different domains (e.g. contributing to a better environment as well as improving one's health).

The transition from adolescence to adulthood (around age 15–25), for example, is a key period of change in which adult identities and lifetime habits are formed, autonomy increases, and ideologies are explored (Nelson, Story, Larson, Neumark-Sztainer, & Lytle, 2008; Solhaug & Kristensen, 2013); this period often sees radical shifts in health, social, and political behaviours, mediated by factors such as family background (Frech, 2012; von Post-Skagegård et al., 2002). Sustainability interventions targeted to emerging adulthood, for example, may have profound and enduring effects, due to links between identity and a range of pro-environmental behaviours (Gatersleben, Murtagh, Cherry, & Watkins, 2017). On the other hand, applying such interventions to other habit discontinuities when values shift may not be so effective; the stress and reduced available time associated with the transition to parenthood, for example, might mitigate intervention effectiveness (Burningham & Venn, 2017; Thompson et al., 2011). This again highlights a need to develop a more differentiated understanding of 'moments of change' that draws out salient dimensions for intervention planning.

Final Thoughts

Behaviour change is difficult, and people vastly underestimate the power habits exert over our lives. However, moments of change can be capitalized upon to encourage the uptake of more adaptive, healthy, safe, pro-social or sustainable behaviours. The evidence reviewed in this chapter offers insights into what has worked and what is needed now, including a more detailed conceptual definition of 'moments of change'; identification of relevant mediators of intervention effectiveness for different types of moment of change; and longitudinal studies to document longer-term effects of efforts to discontinue or disrupt unwanted habits.

Habit Research in Action: Testing Habit Discontinuity Effects

What would constitute a proper test of the Habit Discontinuity Hypothesis (HDH)? If we confine this question to investigating the potential which life course changes may have to boost the effectiveness of behaviour change interventions, there are a number of problems. The gold standard is a fully randomized controlled trial, in particular one that runs sufficiently long in time in order to test the extent of the 'window of opportunity'. Thus, the following elements make a stronger test of the HDH.

1. An intervention versus no-intervention control condition. A prerequisite of a proper HDH test is to make sure one has an intervention that works. The test, then, is whether an intervention is *more* effective in the wake of a habit discontinuity. The inclusion of a control group may occur in several ways, for instance simultaneously with the intervention condition, or in the form of a waitlist-control group.

2. A discontinuity versus no-discontinuity condition. This is not always easy to accomplish. However, the HDH is properly tested by an intervention/no-intervention × discontinuity/no-discontinuity interaction.
3. Random allocation to conditions. This is standard if one wishes to test an intervention. However, problems may arise in implementing this in certain settings. For instance, in the Verplanken and Roy (2016) study, we did not want neighbours to be in different conditions. In such cases a 'clustered randomization' procedure might be the next best option, in this case designating certain areas as 'intervention' and others as 'control'. Random allocation to a discontinuity versus no-discontinuity condition is in most cases impossible, or if it were possible, unethical. The next best solution might then be to match the two groups on key characteristics. However, one will most likely have to accept that the two groups differ in more respects than the discontinuity per se. These differences depend on the type of discontinuity, and may be traced back to socio-economic factors (e.g. in the case of relocation), psychological factors (e.g. divorce), or cohort effects (e.g. retirement).
4. A pre-post discontinuity longitudinal design. The HDH typically plays out over longer periods of time. A HDH design is stronger if one is able to start collecting data before the discontinuity is a fact. Also, in order to establish the size of the 'window or opportunity', sufficient time and measurements are needed as post-measures. One of the difficulties is to know when exactly a 'window of opportunity' opens. For instance, a discontinuity that is anticipated (e.g. retirement), may set things in motion long before the actual moment of retirement. Also, certain discontinuities may be instigated *in order to* change behaviour (e.g. moving house for a better commute). Thus, the timing of measurements is an important element.

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References

Aarts, H., & Dijksterhuis, A. (2000). Habits as knowledge structures: Automaticity in goal-directed behavior. *Journal of Personality and Social Psychology, 78*, 53–63. https://doi.org/10.1037/0022-3514.78.1.53

Aarts, H., Verplanken, B., & van Knippenberg, A. (1997). Habit and information use in travel mode choices. *Acta Psychologica, 96*, 1–14. https://doi.org/10.1016/S0001-6918(97)00008-5

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. https://doi.org/10.1111/j.1559-1816.1998.tb01681.x

Adriaanse, M. A., Gollwitzer, P. M., De Ridder, D. T., de Wit, J. B. F., & Kroese, F. M. (2011). Breaking habits with implementation intentions: A test of underlying processes. *Personality and Social Psychology Bulletin, 37*, 502–513. https://doi.org/10.1177/0146167211399102

Anderson, B. A., & Yantis, S. (2013). Persistence of value-driven attentional capture. *Journal of Experimental Psychology: Human Perception and Performance, 39*, 6–9. https://doi.org/10.1037/a0030860

Axon, S. (2017). "Keeping the ball rolling": Addressing the enablers of, and barriers to, sustainable lifestyles. *Journal of Environmental Psychology, 52*, 11–25. https://doi.org/10.1016/j.jenvp.2017.05.002

Bamberg, S. (2006). Is a residential relocation a good opportunity to change people's travel behaviour? Results from a theory-driven intervention study. *Environment and Behaviour, 38*, 820–840. https://doi.org/10.1177/0013916505285091

Bardi, A., Buchanan, K. E., Goodwin, R., Slabu, L., & Robinson, M. (2014). Value stability and change during self-chosen life transitions: Self-selection versus socialization effects. *Journal of Personality and Social Psychology, 106*, 131–147. https://doi.org/10.1037/a0034818

Barnett, I., van Sluijs, E. M. F., & Ogilvie, D. (2012). Physical activity and transitioning to retirement: A systematic review. *American Journal of Preventive Medicine, 43*, 329–336. https://doi.org/10.1016/j.amepre.2012.05.026

Beige, S., & Axhausen, K. W. (2012). Interdependencies between turning points in life and long-term mobility decisions. *Transportation, 39*, 857–872. https://doi.org/10.1007/s11116-012-9404-y

Best, D., Beckwith, M., Haslam, C., Haslam, S. A., Jetten, J., Mawson, E., et al. (2016). Overcoming alcohol and other drug addiction as a process of social identity transition: The social identity model of recovery (SIMOR). *Addiction Research & Theory, 24*, 111–123. https://doi.org/10.3109/16066359.2015.1075980

Burningham, K., & Venn, S. (2017). Are lifecourse transitions opportunities for moving to more sustainable consumption? *Journal of Consumer Culture*, published online. https://doi.org/10.1177/1469540517729010.

Busch-Geertsema, A., & Lanzendorf, M. (2017). From university to work life—jumping behind the wheel? Explaning mode change of students making the transition to professional life. *Transportation Research Part A, 106*, 181–196. https://doi.org/10.1016/j.tra.2017.09.016

Clark, B., Chatterjee, K., & Melia, S. (2016). Changes to commute mode: The role of life events, spatial context and environmental attitude. *Transportation Research Part A, 89*, 89–105. https://doi.org/10.1016/j.tra.2016.05.005

Cummings, S., Bridgman, T., & Brown, K. G. (2016). Unfreezing change as three steps: Rethinking Kurt Lewin's legacy for change management. *Human Relations, 69*, 33–60. https://doi.org/10.1177/0018726715577707

Derksen, L., & Gartrell, J. (1993). The social context of recycling. *American Sociological Review, 58*, 434–442. https://doi.org/10.2307/2095910

Epiphaniou, E., & Ogden, E. (2010). Successful weight loss maintenance and a shift in identity: From restriction to a new liberated self. *Journal of Health Psychology, 15*, 887–896. https://doi.org/10.1177/1359105309358115

Fatmi, M. R., & Habib, M. A. (2017). Modelling mode switch associated with the change in residential location. *Travel Behaviour and Society, 9*, 21–28. https://doi.org/10.1016/j.tbs.2017.07.006

Frech, A. (2012). Healthy behavior trajectories between adolescence and young adulthood. *Advances in Life Course Research, 17*, 59–68. https://doi.org/10.1016/j.alcr.2012.01.003

Fujii, S., & Gärling, T. (2003). Development of script-based travel mode choice after forced change. *Transportation Research Part F, 6*, 117–124. https://doi.org/10.1016/S1369-8478(03)00019-6

Fujii, S., Gärling, T., & Kitamura, R. (2001). Changes in drivers' perceptions and use of public transport during a freeway closure: Effects of temporary structural change on cooperation in a real-life social dilemma. *Environment and Behaviour, 33*, 796–808. https://doi.org/10.1177/00139160121973241

Gatersleben, B., Murtagh, N., Cherry, M., & Watkins, M. (2017). Moral, wasteful, frugal, or thrifty? Identifying consumer identities to understand and manage pro-environmental behavior. *Environment and Behavior,* published online. https://doi.org/10.1177/0013916517733782.

Giddens, A. (1991). *Modernity and self-identity*. Cambridge: Polity Press.

Gollwitzer, P. M., & Brandstätter, V. (1997). Implementation intentions and effective goal pursuit. *Journal of Personality and Social Psychology, 73*, 186–199. https://doi.org/10.1037/0022-3514.73.1.186

Gollwitzer, P. M., Heckhausen, H., & Steller, B. (1990). Deliberative and implemental mind-sets: Cognitive tuning toward congruous thoughts and information. *Journal of Personality and Social Psychology, 59*, 1119–1127. https://doi.org/10.1037/0022-3514.59.6.1119

Goodwin, P. B. (1989). Family changes and public transport use 1984-1987: A dynamic analysis using panel data. *Transportation, 16*, 121–154. https://doi.org/10.1007/BF00163112

Guell, C., Panter, J., Jones, N. R., & Ogilvie, D. (2012). Towards a differentiated understanding of active travel behaviour: Using social theory to explore everyday commuting. *Social Science & Medicine, 75*, 233–239. https://doi.org/10.1016/j.soscimed.2012.01.038

Hards, S. (2012). Tales of transformation: The potential of a narrative approach to pro-environmental practices. *Geoforum, 43*, 760–771. https://doi.org/10.1016/j.geoforum.2012.01.004

Heinen, E., Panter, J., Mackett, R., & Ogilvie, D. (2015). Changes in mode of travel to work: A natural experimental study of new transport infrastructure. *International Journal of Behavioral Nutrition and Physical Activity, 12*, 81. https://doi.org/10.1186/s12966-015-0239-8

Jones, C. H. D., & Ogilvie, D. (2012). Motivations for active commuting: A qualitative investigation of the period of home or work relocation. *International Journal of Behavioral Nutrition and Physical Activity, 9*, 109. https://doi.org/10.1186/1479-5868-9-109

Kearney, M. H., & O'Sullivan, J. (2003). Identity shifts as turning points in health behavior change. *Western Journal of Nursing Research, 25*, 134–152. https://doi.org/10.1177/0193945902250032

Kim, H. S., Wohl, M. J. A., Salmon, M., & Santesso, D. (2017). When do gamblers help themselves? Self-discontinuity increases self-directed change over time. *Addictive Behaviors, 64*, 148–153. https://doi.org/10.1016/j.addbeh.2016.08.037

Koehn, S., Gillison, F., Standage, M., & Bailey, J. (2016). Life transitions and relevance of healthy living in late adolescence. *Journal of Health Psychology, 21*, 1085–1095. https://doi.org/10.1177/1359105314546340

Kurz, T., Gardner, B., Verplanken, B., & Abraham, C. (2015). Habitual behaviours or patterns of practice? Explaining and changing repetitive climate-relevant actions. *Wiley Interdisciplinary Reviews: Climate Change, 6*, 113–128. https://doi.org/10.1002/wcc.327

Langer, E., Blank, A., & Chanowitz, B. (1978). The mindlessness of ostensibly thoughtful action: The role of "placebic" information in interpersonal interaction. *Journal of Personality and Social Psychology, 36*, 635–642. https://doi.org/10.1037/0022-3514.36.6.635

Lawson, P. J., & Flocke, S. A. (2009). Teachable moments for health behavior change: A concept analysis. *Patient Education and Counseling, 76*, 25–30. https://doi.org/10.1016/j.pec.2008.11.002

Lewin, K. (1947). Frontiers in group dynamics: Concept, method and reality in social science; social equilibria and social change. *Human Relations, 1*, 5–41. https://doi.org/10.1177/001872674700100103

Maio, G. R. (2017). *The psychology of human values*. London: Routledge.

Maréchal, K. (2010). Not irrational but habitual: The importance of "behavioural lock-in" in energy consumption. *Ecological Economics, 69*, 1104–1114. https://doi.org/10.1016/j.ecolecon.2009.12.004

Marsden, G., & Docherty, I. (2013). Insights on disruptions as opportunities for transport policy change. *Transportation Research Part A, 51*, 46–55. https://doi.org/10.1016/j.tra.2016.07.006

Matthies, E., Klöckner, C. A., & Preißner, C. L. (2006). Applying a modified moral decision making model to change habitual car use: How can commitment be effective? *Applied Psychology: An International Review, 55*, 91–106. https://doi.org/10.1111/j.1464-0597.2006.00237.x

McBride, C. M., Emmons, K. M., & Lipkus, I. M. (2003). Understanding the potential of teachable moments: The case of smoking cessation. *Health Education Research, 18*, 156–170. https://doi.org/10.1093/her/18.2.156

Mein, G. K., Shipley, M. J., Hillsdon, M., Ellison, G. T. H., & Marmot, M. G. (2005). Work, retirement and physical activity: Cross-sectional analyses from the Whitehall II study. *European Journal of Public Health, 15*, 317–322. https://doi.org/10.1093/eurpub/cki087

Midanik, L. T., Soghikian, K., Ransom, L. J., & Tekawa, I. S. (1995). The effect of retirement on mental health and health behaviors: The Kaiser Permanente retirement study. *Journal of Gerontology, 50B*, S59–S61. https://doi.org/10.1093/geronb/50B.1.S59

Nelson, M. C., Story, M., Larson, N. I., Neumark-Sztainer, D., & Lytle, L. A. (2008). Emerging adulthood and college-aged youth: An overlooked age for weight-related behavior change. *Obesity, 16*, 2205–2211. https://doi.org/10.1038/oby.2008.365

Nicolson, M., Huebner, G. M., Shipworth, D., & Elam, S. (2017). Tailored emails prompt electric vehicle owners to engage with tariff switching information. *Nature Energy, 2*, 17073. https://doi.org/10.1038/nenergy.2017.73

Parkes, S. D., Jopson, A., & Marsden, G. (2016). Understanding travel mode behaviour during mega-events: Lessons from the London 2012 games. *Transportation Research Part A, 92*, 104–119. https://doi.org/10.1016/j.tra.2016.07.006

Poortinga, W., Whitmarsh, L., & Suffolk, C. (2013). The introduction of a single-use carrier bag charge in Wales: Attitude change and behavioural spillover effects. *Journal of Environmental Psychology, 36*, 240–247. https://doi.org/10.1016/j.jenvp.2013.09.001

Ralph, K. M., & Brown, A. E. (2017). The role of habit and residential location in travel behavior change programs, a field experiment. *Transportation*. https://doi.org/10.1007/s11116-017-9842-7

Rebar, A., Gardner, B., Rhodes, R. E., & Verplanken, B. (2018). The measurement of habit. In B. Verplanken (Ed.), *The psychology of habit* (pp. xx–xx). New York: Springer.

Rogers, B. L., Vardaman, J. M., Allen, D. G., Muslin, I. S., & Brock Baskin, M. (2016). Turning up by turning over: The change of scenery effect in major league baseball. *Journal of Business and Psychology, 32*, 547–560. https://doi.org/10.1007/s10869-016-9468-3

Roy, D., Verplanken, B., & Griffin, C. (2015). Making sense of sustainability: Exploring the subjective meaning of sustainable consumption. *Applied Environmental Education and Communication, 14*, 187–195. https://doi.org/10.1080/1533015X.2015.1067581

Schäfer, M., Jaeger-Erben, M., & Bamberg, S. (2012). Life events as windows of opportunity for changing towards sustainable consumption patterns? Results from an intervention study. *Journal of Consumer Policy, 35*, 65–84. https://doi.org/10.1007/s10603-011-9181-6

Scheiner, J. (2006). Housing mobility and travel behaviour: A process-oriented approach to spatial mobility. Evidence from a new research field in Germany. *Journal of Transport Geography, 14*, 287–298. https://doi.org/10.1016/j.jtransgeo.2005.06.007

Scheiner, J., & Holz-Rau, C. (2013). A comprehensive study of life course, cohort, and period effects on changes in travel mode use. *Transportation Research Part A, 47*, 167–181. https://doi.org/10.1016/j.tra.2012.10.019

Schulz, M. S., Cowan, C. P., & Cowan, P. A. (2006). Promoting healthy beginnings: A randomized controlled trial of a preventive intervention to preserve marital quality during the transition to parenthood. *Journal of Consulting and Clinical Psychology, 74*, 20–31. https://doi.org/10.1037/0022-006X.74.1.20

Schwanen, T., Banister, D., & Anable, J. (2012). Rethinking habits and their role in behaviour change: The case of low-carbon mobility. *Journal of Transport Geography, 24*, 522–532. https://doi.org/10.1016/j.jtrangeo.2012.06.003

Shove, E., Pantzar, M., & Watson, M. (2012). *The dynamics of social practice: Everyday life and how it changes*. London: Sage.

Smeaton, D., Barnes, H., & Vegeris, S. (2017). Does retirement offer a "window of opportunity" for lifestyle change? Views from English workers from the cusp of retirement. *Journal of Aging and Health, 29*, 25–44. https://doi.org/10.1177/0898264315624903

Solhaug, T., & Kristensen, N. N. (2013). Political learning among youth: Exploring patterns of students' first political awakening. *Citizenship, Social and Economics Education, 12*, 174–185.

Stanbridge, K. & Lyons, G. (2006). Travel behaviour considerations during the process of residential relocation. In: *11th International Conference on Travel Behaviour Research,* Kyoto, Japan, 16th–20th August, 2006.

Stern, P. (2000). Toward a coherent theory of environmentally significant behavior. *Journal of Social Issues, 56*, 407–424. https://doi.org/10.1111/0022-4537.00175

Thøgersen, J. (2012). The importance of timing for breaking commuters' car driving habits. In A. Warde & D. Southerton (Eds.), *The habits of consumption* (pp. 130–140). Helsinki: Helsinki Collegium for Advances Studies.

Thomas, G. O., Fisher, R., Whitmarsh, L., Milfont, T. L., & Poortinga, W. (2018). The impact of parenthood on environmental attitudes: A longitudinal investigation of the legacy hypothesis. *Population and Environment, 39*, 261–276. https://doi.org/10.1007/s11111-017-0291-1

Thomas, G. O., Poortinga, W., & Sautkina, E. (2016). Habit discontinuity, self-activation, and the diminishing influence of context change: Evidence from the UK Understanding Society Survey. *PLoS One, 11*, e0153490. https://doi.org/10.1371/journal.pone.0153490

Thompson, S., Michaelson, J., Abdallah, S., Johnson, V., Morris, D., Riley, K., et al. (2011). *Moments of change as opportunities for influencing behaviour: A report to the Department for Environment, Food and Rural Affairs*. Defra: The New Economics Foundation.

Verplanken, B., & Aarts, H. (1999). Habit, attitude, and planned behaviour: Is habit an empty construct or an interesting case of goal-directed automaticity? *European Review of Social Psychology, 10*, 101–134. https://doi.org/10.1080/14792779943000035

Verplanken, B., Aarts, H., & van Knippenberg, A. (1997). Habit, information acquisition, and the process of making travel mode choices. *European Journal of Social Psychology, 27*, 539–560. https://doi.org/10.1002/(SICI)1099-0992(199709/10)27:5

Verplanken, B., & Holland, R. W. (2002). Motivated decision-making: Effects of activation and self-centrality of values on choices and behavior. *Journal of Personality and Social Psychology, 82*, 434–447. https://doi.org/10.1037/0022-3514.82.3.434

Verplanken, B., & Roy, D. (2016). Empowering interventions to promote sustainable lifestyles: Testing the habit discontinuity hypothesis in a field experiment. *Journal of Environmental Psychology, 45*, 127–134. https://doi.org/10.1016/j.jenvp.2015.11.008

Verplanken, B., Walker, I., Davis, A., & Jurasek, M. (2008). Context change and travel mode choice: Combining the habit discontinuity and self-activation hypotheses. *Journal of Environmental Psychology, 28*, 121–127. https://doi.org/10.1016/j.envp.2007.10.005

Verplanken, B., & Wood, W. (2006). Interventions to break and create consumer habits. *Journal of Public Policy and Marketing, 25*, 90–103. https://doi.org/10.1509/jppm.25.1.90

von Post-Skagegård, M., Samuelson, G., Karlstrom, B., Mohsen, R., Berglund, L., & Bratteby, L. E. (2002). Changes in food habits in healthy Swedish adolescents during the transition from adolescence to adulthood. *European Journal of Clinical Nutrition, 56*, 532–538.

Walker, I., Thomas, G. O., & Verplanken, B. (2015). Old habits die hard: Travel habit formation and decay during an office relocation. *Environment & Behavior, 47*, 1089–1106. https://doi.org/10.1177/0013916514549619

Webb, J., Fife-Shaw, C., Ogden, J., & Foster, J. (2017). The effect of the 'Move More' pack on the physical activity of cancer survivors: Protocol for a randomized waiting list control trial with process evaluation. *JMIR Research Protocols, 6*, 1–12.

Whitmarsh, L., & O'Neill, S. (2010). Green identity, green living? The role of pro-environmental self-identity in determining consistency across diverse pro-environmental behaviours. *Journal of Environmental Psychology, 30*, 305–314. https://doi.org/10.1016/j.envp.2010.01.003

Williams, D. (1999). Life events and career change: Transition psychology in practice. Paper presented to the *British Psychological Society's Occupational Psychology Conference,* January 1999. Retrieved from http://www.eoslifework.co.uk/transprac.htm.

Wood, W., & Neal, D. T. (2007). A new look at habits and the habit-goal interface. *Psychological Review, 114*, 843–863. https://doi.org/10.1037/0033-295X.114.4.843

Wood, W., Quinn, J. M., & Kashy, D. A. (2002). Habits in everyday life: Thought, emotion, and action. *Journal of Personality and Social Psychology, 83*, 1281–1297. https://doi.org/10.1037/022-3514.83.6.1281

Wood, W., & Rünger, D. (2016). Psychology of habit. *Annual Review of Psychology, 67*, 11.1–11.26. https://doi.org/10.1146/annurev-psych-122414-033417

Wood, W., Tam, L., & Guerrero Witt, M. (2005). Changing circumstances, disrupting habits. *Journal of Personality and Social Psychology, 88*, 918–933. https://doi.org/10.1037/0022-3514.88.6.918

Chapter 12
Modelling Habit Formation and Its Determinants

Benjamin Gardner and Phillippa Lally

Behavioural risk factors have been implicated in half of all deaths in the US (Danaei et al., 2009). Adopting health-promoting behaviours, such as a healthy diet or regular physical activity, or substituting health-risk behaviours for healthier alternatives, such as using nicotine replacement therapy instead of smoking, could extend lives. For many actions, change must be lasting for health and related benefits to be realised; eating one apple, for example, has negligible health impact.

Where goals require repeated action—for example, weight loss, which requires a consistently healthy diet, or regular exercise—behaviour change is a long-term process. People are relatively well-equipped to summon the motivation and willpower needed to adopt new behaviours, but typically struggle to maintain them (Dombrowski, Knittle, Avenell, Araújo-Soares, & Sniehotta, 2010). This may at least partly be attributable to motivation failure (Kwasnicka, Dombrowski, White, & Sniehotta, 2016); people may deprioritise the behaviour, or lose motivation, becoming less willing to invest necessary effort.

Habit formation has been proposed as a mechanism for behaviour maintenance (see Rothman, Sheeran, & Wood, 2009). 'Habit' describes a process whereby encountering a cue triggers an impulse to perform an action that has, through learning, become a learned response to the cue; 'habitual behaviours' are controlled by this process (Gardner, 2015; Wood & Rünger, 2016). Behavioural repetition in the presence of a contextual cue strengthens a mental cue–behaviour association, to the point that perceiving the cue triggers a mental representation that elicits action with minimal conscious oversight (Neal, Wood, Labrecque, & Lally, 2012; Wood, Labrecque, Lin, & Rünger, 2015). As habit forms, behavioural regulation is

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transferred from a conscious, deliberative information-processing system, to an impulsive, association-driven system, which triggers action rapidly and efficiently (Strack & Deutsch, 2004). By virtue of their cue-dependent, automatic nature (Orbell & Verplanken, 2010), habitual behaviours can persist even where people lack conscious motivation to perform them. Habit strength has consistently been shown to be associated with performance frequency (Gardner, de Bruijn, & Lally, 2011) and, moreover, to bridge the 'gap' between intention and behaviour, making people more likely to act on positive intentions (de Bruijn, Rhodes, & van Osch, 2012)—or, in some cases, despite intentions *not* to act (Neal, Wood, Wu, & Kurlander, 2011; Orbell & Verplanken, 2010). Habitual behaviours persist even where they no longer serve the goal that motivated initial performance (Wood & Neal, 2007). Habit formation may thus 'lock in' behaviours, shielding them from motivation losses (Rothman et al., 2009; Verplanken & Wood, 2006).

Developing effective habit-forming interventions depends on understanding how habit forms. Conceptually, habit formation is simple: behaviour must be repeated in a consistent context, to develop context–behaviour associations that subsequently regulate behaviour. In reality however, habit formation is often challenging. This chapter summarises evidence about how habit forms, and how formation might be facilitated. We describe the few studies that have tracked real-world habit formation and its potential determinants and outline a framework for understanding the formation process. We aim to not only generate recommendations for habit-based behaviour change interventions but also map out fruitful territory for future research.

Modelling Habit Formation

Most empirical evidence of habit formation has arisen from animal-learning studies (Dickinson, 1985; Thorndike, 1911; Tolman, 1932). These consistently show that an animal repeatedly rewarded for certain responses to a stimulus will continue to exhibit those responses in later stimulus encounters, even where the initially rewarding outcome is devalued (Dickinson, 1985). Lab-based work has documented the same responses to experimental stimuli among humans (see de Wit & Dickinson, 2009). These studies illustrate core principles of habit and its formation: the importance of consistent cue–behaviour pairings; the role of operant conditioning in developing cue–behaviour associations, whereby positive outcomes reinforce associations; and the goal-independent and persistent nature of habitual responses (de Wit & Dickinson, 2009).[1] Animal research is of course of limited relevance to real-world human behaviour change. Unlike rats, we possess the cognitive capacity to anticipate and reflect on actions and likely outcomes and only pursue attractive

[1] Given current interest in habit, it is ironic that some seminal empirical insights into habit formation were more incidental than purposeful. Tolman (1932) was irritated by habit-learning among his rats, viewing the development of goal-independent responses as mere noise that interfered with the study of more interesting learning processes: *"the animal becomes 'fixated' upon a particular route. He persists in choosing it, willy nilly, even though in later trials it provides no longer preponderantly good. […] [These] so-called 'position-habits' … are such a nuisance to an experimenter"* (p. 153).

actions that we feel able to perform (Michie, van Stralen, & West, 2011; Rothman, 2000). Evidence of habit formation in humans is required.

Few studies have tracked habit development for actions commonly targeted by behaviour change interventions, such as diet and physical activity. Some studies purported to do so but measured only performance frequency (Armitage, 2005), and so failed to discern habitual from non-habitual action. Advances in measurement—specifically, development of a Self-Report Habit Index (SRHI; Verplanken & Orbell, 2003)—have permitted more valid studies.

One study explored the relationship between behavioural repetition and habit formation (Lally, van Jaarsveld, Potts, & Wardle, 2010). Ninety-six participants were instructed to repeat a new, self-chosen physical activity or dietary behaviour daily for 12 weeks, in response to a self-identified once-daily cue (see the ‘Habit Research in Action’ box). They completed a daily online questionnaire, reporting whether they had performed the behaviour and its automaticity, using an abbreviated SRHI (Verplanken & Orbell, 2003). Automaticity gains for each participant were fitted against an asymptotic curve model, which assumes that initially rapid increases decelerate and plateau over time. The curve was a good fit for 39 of 82 participants with sufficient data for analysis. There was variation in the level at which habit strength plateaued, with some peaking at a high score, and others at the scale mid-range. The median time for each participant to reach their personal habit plateau was 66 days, though this ranged from 18 to 254 days, as statistically extrapolated beyond the study period. This study demonstrated the typical habit growth trajectory, while also showing that the strength at which habit peaks and speed with which it develops vary, possibly across people or behaviours, despite equal repetitions.

Other studies have modelled both habit formation and its influences. In one study, 42 participants undertook a novel stretch daily for 90 days (Fournier et al., 2017). Half stretched in the morning upon waking, and others in the evening, immediately before bed. Behaviour and habit were assessed daily via smartphone, using an automaticity-specific SRHI subscale (the Self-Report Behavioural Automaticity Index [SRBAI]; Gardner, Abraham, Lally, & de Bruijn, 2012). Echoing Lally et al. (2010), within-person habit development was best depicted asymptotically.[2] Between-group comparison of growth curves indicated that habit peaked more quickly for those stretching in the morning (105 days) versus the evening (154 days; Fournier et al., 2017).

These are the only two quantitative studies to our knowledge to have tracked habit *within* individuals (for a qualitative account, see Lally, Wardle, & Gardner, 2011). Other studies have observed habit development using group-level aggregation. For example, Kaushal and Rhodes (2015) investigated gym attendance habit formation among new members over 12 weeks. Habit (SRBAI), exercise frequency

[2] While both studies modelled habit asymptotically, Fournier, et al., (2017) fitted a logistic function, which they argued offered superior fit than did the exponential curve used by Lally et al. (2010). This curve has a slower initial increase than the sharp early increases observed by Lally et al. (2010). These differences may reflect different study procedures (unlike Fournier and colleagues’ participants, for example, Lally et al.’s formed implementation intentions), or methodological differences such as limits set on curve parameter values. Further work is needed to rigorously compare the two curve equations across different study designs.

and duration were measured at baseline, and 6, 9 and 12 weeks post-baseline. Habit development was captured via survival analysis, assessing the statistical significance of average changes in group-level habit scores over time. A cut-off SRBAI value was identified that, on average, differentiated between people achieving 150 weekly minutes of physical activity and those not. Participants self-reported the affectively rewarding nature of exercise, performance consistency, conduciveness of environmental features to exercise, and perceived difficulty of exercising. The authors concluded that exercising at least four times weekly for 6 weeks was necessary for habit formation, and that consistency, low complexity, environmental conduciveness and positive affect strengthened habit.

Other formation studies have modelled group-level habit scores and their determinants linearly. Linear accounts are problematic, because they imply that each repetition—whether the fourth, or 444th—strengthens habit equally. Theory and evidence, however, favour asymptotic development, with the contribution of each repetition varying in magnitude at different points in the trajectory (Fournier et al., 2017; Hull, 1943; Lally et al., 2010). Nonetheless, these studies highlight variables for investigation in more methodologically robust work. A 28-week study of workplace exercise class attendance, for example, found that habit strength (SRBAI) increased steadily for all participants (Fournier, d'Arripe-Longueville, & Radel, 2017). Those who received SMS reminders before the scheduled session reported stronger habit at all timepoints. A flossing habit formation study tracked 50 participants at 4 weeks and 8 months post-baseline (Judah, Gardner, & Aunger, 2013). All participants received a motivational intervention, outlining how and why to floss, and planned when they would floss. Half were instructed to floss before brushing their teeth, and half afterwards. Four weeks later, habit was stronger among those who flossed more frequently in the intervening period. Among the 29 (58%) participants who responded 8 months post-baseline, habit was marginally stronger for those flossing after brushing.

These studies concur with animal-based studies in showing that habit forms via context-dependent repetition. They also point to uniquely human factors, such as motivation and self-regulation in opportune settings. Accounts of human habit formation must incorporate both the associative processes that we share with other animals, and the controlled, deliberative processes afforded by higher-order cognitive capabilities (Wood & Neal, 2007).

A Framework for Understanding Habit Formation and Its Determinants

We have proposed a framework for understanding habit formation and its determinants, consisting of four stages (see Fig. 12.1) (Lally & Gardner, 2013). At stage 1, actors decide whether to perform a new action.[3] Psychological activity at this stage

[3] While not explicitly empirically tested, it is unlikely that habit formation, while typically arising from repeated enactment of intentions *to act*, requires an intention *to form a habit.* People who

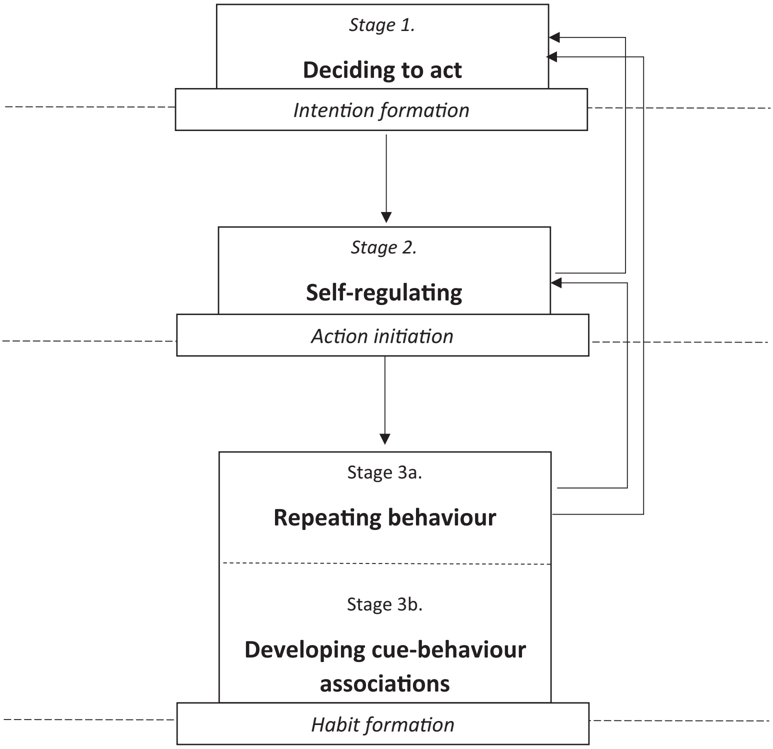

Fig. 12.1 A framework for understanding habit formation and its determinants

focuses on deliberation over action and outcomes and culminates in intention formation. At stage 2, actors mobilise the resources required to translate intention into action. The stage is characterised by self-regulatory strategies such as planning (Fleig et al., 2013), and culminates in action initiation. At stage 3a, the behaviour is repeated, which demands sustained motivation and self-regulation. At stage 3b, the new action is repeated *in a manner conducive to development of habit associations*. Consistent enactment following exposure to a cue develops cue-behaviour links, which acquire the potential to generate subsequent automatic responses to the cue (Wood & Neal, 2007). As denoted by their numbering, stages 3a and 3b occur concurrently, but the distinction usefully distinguishes between repetition per se (stage 3a) and the strengthening of cue–response associations (stage 3b). Stages 3a and 3b culminate in habit formation, whereby regulation of behaviour is successfully

decide to gamble for the first time, for example, do not do so with the aim of developing gambling habits. Nonetheless, aspects of the gambling experience—such as the pleasure of a big win—reinforce behaviour and develop habit associations, regardless of the actor's initial goals (Blaszczynski & Nower, 2002).

transferred from conscious to non-conscious mental processes.[4] An individual may revisit earlier stages prior to habit forming; initial experiences of action (stage 3a) may, for example, reduce motivation to act (stage 1), precluding further repetition. For example, the behaviour may lose its value over time, or the expected outcomes of the behaviour may not be realised, leading to a weakening of intentions to act (Rothman, 2000). Alternatively, the action may become less appealing than competing alternatives, such that intentions for the focal action are assigned lesser priority than intentions to perform other actions (Cantor & Blanton, 1996). When habit has formed, however, any subsequent changes in motivation (stage 1) are unlikely to inhibit future performance.

This framework, which can be applied across any timescale, echoes extant stage models of behaviour change. For example, stages 1 and 2 represent the preactional phases, and stage 3a the actional phase, of the Rubicon Model of Action Phases (Heckhausen & Kuhl, 1985; see too Prochaska & DiClemente, 1983). Stages 1-3a capture generic behaviour change, because habit formation requires initiation and repetition of a new behaviour (Fournier et al., 2017; Lally et al., 2010). The novelty of our framework lies in stage 3b, which focuses on developing the mental associations that drive habitual behaviour.

Our framework is designed to aid conceptual organisation of potential determinants of habit formation. A variable influences habit development if it alters the likelihood that an individual will intend to act (stage 1), act on intentions (stage 2), or remain motivated and capable after attempting the action (stage 3a); or if it directly influences development of mental associations arising from context-dependent repetition (stage 3b). A variable may operate at multiple stages; for example, anticipated pleasure may incentivise performance (stage 1), sustain motivation (stage 3a), and quicken cue-behaviour learning (stage 3b) (Radel, Pelletier, Pjevac, & Cheval, 2017).

Next, we review evidence around potential determinants of habit formation, drawing not only on habit development tracking studies but also on theoretical principles, and insights from studies of established habits. The latter work focuses on potential sources of between-person variation in habit for ongoing behaviours, which may not reliably reflect within-person determinants of habit formation but can nonetheless highlight variables worthy of exploration in formation studies. Indeed, given a paucity of formation studies, our discussion aims to primarily generate hypotheses for future research into factors that may facilitate habit formation, though we also offer tentative recommendations for practice. We do not review determinants of behaviour change per se, instead restricting focus to factors of pertinence to promoting the context-dependent repetition necessary to foster habit associations, above and beyond influence on the behaviour change process upon which habit formation depends.

[4] A more realistic depiction of the endpoint of stages 3a and 3b is that habit strength peaks. Habit strength is better represented as a continuum than a simple ‘habit-no habit’ dichotomy (Moors & de Houwer, 2006). This complicates attempts to distinguish a ‘habitual’ from a ‘non-habitual’ response. As Lally et al. (2010) showed, it is possible for habit strength to peak at only a moderate level, such that, in crude terms, an actor can be thought to have shifted from a ‘weak’ habit to a ‘moderate’ habit, rather than achieving a ‘strong’ habit.

Factors Determining the Development of Habit Associations

Habit forms when a person repeatedly acts in the presence of environmental cues. Determinants of formation can thus be crudely discerned into factors relating to cues, behaviours, and the actor.

Cue-Related Factors

Planning

Intentions do not always correspond with behaviour (Webb & Sheeran, 2006). While some people may act despite not intending to do so (Orbell & Verplanken, 2010), for 'good' behaviours such as physical activity, the intention–behaviour gap is almost exclusively due to failing to act on positive intentions (Rebar, Rhodes & Gardner, 2018). Action plans specifying what will be done in a given situation increase the likelihood of action (Schüz, Sniehotta, Wiedemann, & Seemann, 2006). Implementation intentions are a subtype of action plan, requiring detailed specification of a context and the behaviour to be performed in that context (Gollwitzer, 1999).

Planning may be particularly useful for habit formation (Fleig et al., 2013; see also Chap. 10 in this volume). Planning helps people remember to act in opportune settings (stage 2 in our framework). Additionally, anticipating environments suitable for performance, and how action will precede in these environments, is conducive to developing cue–behaviour associations (stage 3b). Gollwitzer (1999) views implementation intentions as creating 'instant habit': after mentally binding actions to anticipated contexts, encountering the context prompts the action automatically, via the same associative pathway as habit (Webb & Sheeran, 2007). Action planning thus provides the cognitive architecture through which intentional actions may become habitual. Indeed, Orbell and Verplanken (2010) showed implementation intentions to enhance dental flossing frequency and habit strength.

Cue Salience and Stability

In theory, any contextual feature can become a habit cue (Verplanken, 2005), but some contexts may be more suited to supporting habit. One study found that people who consistently exercised with the same people, in the same part of their routine, or in the same mood, reported stronger physical activity habits (Pimm et al., 2016). The idiosyncratic nature of habit associations, precludes generalisation from these findings across behaviours. It may be more beneficial to focus on *properties* of optimal cues than to identify common, idiosyncratic cues.

Habit development is likely optimally facilitated by pairing behaviour with more salient, accessible and perceptible environmental features (Lally & Gardner, 2013). In one study, participants underlined the word 'she', or references to 'a mammal or a moveable object' in a text (Verplanken, 2006). Both groups underlined the same number of words, but those for whom identifying the cue was more difficult (mammals or moveable objects) subsequently reported weaker habit.

Some cues may be inherently more or less perceptible. Event-based cues (e.g. 'after breakfast') may be more suitable than time-based cues (e.g. 'at 10 a.m.'), which require conscious monitoring (McDaniel & Einstein, 2000). Preceding actions have particular value as event-based cues for behaviours most appropriately performed following other actions (e.g. taking medication after a meal). For example, flossing is more likely to be adopted into a morning or evening 'hygiene' routine, than performed in the middle of the day (Schüz et al., 2006). Identifying optimal positioning for new behaviours within existing routines requires understanding of how people mentally represent their actions (Cooper & Shallice, 2000; Vallacher & Wegner, 1987). Any one action may be broken down into a series of 'sub-actions' that are perceptually 'chunked' into what is perceived to be a single unit of action (Cooper & Shallice, 2000). For example, 'preparing instant coffee' can be deconstructed into lower-level actions such as 'putting sugar into coffee', 'putting milk into coffee', and 'grinding coffee'. These in turn may be further deconstructed; 'putting sugar into coffee' subsumes 'holding spoon', 'adding sugar from packet', and 'putting down spoon'. Theory is mixed regarding where best to place new behaviours within such sequences; for example, whether flossing should become the first action in a 'dental hygiene' routine, or whether it should be incorporated in the middle, or at the end, of the routine. One argument is that new behaviours should be placed at the boundary between completion of one higher-order action and initiation of another. People would likely be less attentive to the cessation of one component of a perceptually unitary 'dental hygiene' routine than to the completion of a preceding routine, such as 'showering' (Vallacher & Wegner, 1987). Additionally, interrupting the execution of an established routine can lead to slower performance, more errors, and more negative affective experiences (Bailey & Konstan, 2006), possibly due to the cognitive burden involved in the conscious attention needed to identify cues and regulate normally non-conscious action (Gillie & Broadbent, 1989). Inserting a new behaviour at the start of a routine should therefore increase the likelihood that people will notice and act upon the cue (i.e. the cessation of a preceding routine). Conversely, however, people experience most action slips and act contrary to their intentions at such 'large' 'task boundaries' (Botvinick & Bylsma, 2005), presumably because the perceptual link between one routine (showering) and another (flossing) is weak. It could thus be counterargued that new behaviours are *more* likely to become habitual when inserted into the middle of a related sequence, because one action (e.g. brushing teeth) may be more likely to trigger a closely related new action (flossing). This is tentatively supported by Judah et al.'s study that showed that people flossing daily after brushing reported stronger flossing habit at 8-month follow-up than those flossing before brushing (Judah et al., 2013). Notably however, at the study outset, participants completed implementation intentions specifying the cue (e.g. 'brushing my teeth') to flossing, which may have made brushing cessation a more mentally accessible cue.

Further research is needed to identify where, within the constant flow of everyday actions, new behaviours are best placed for habit formation. The optimal solution may well be nuanced; while it may be more effortful to form habit for a behaviour inserted in the middle of an existing sequence due to reduced cue salience, people who can mobilise sufficient attentional resources to perform the action in this position may perhaps form habit more strongly, or more quickly.

Behaviour-Related Factors

Consistency

Habit formation requires consistent, but not necessarily frequent, action. Although often studied in relation to actions performed at least once a day, habit can form for less frequent behaviours (e.g. weekly recycling; Klöckner & Oppedal, 2011).

Developing cue–behaviour associations depends on consistent cue–behaviour pairings; performing multiple behaviours in response to a cue dilutes the mental association between that cue and any one behaviour, limiting the likelihood that a behaviour will become habitual (Wood & Neal, 2007). Among Kaushal and Rhodes' (2015) gym-goers, those more consistently exercising in the presence of certain cues ('every morning at 7am, or daily after supper'; p. 655) reported greatest habit gains at 12-week follow-up. The level of consistency required is unclear. Lally et al. (2010) found that a single missed performance had negligible impact on habit. Inconsistent performance may nonetheless hinder habit formation, because failing to act reduces the likelihood of subsequent performance, derailing maintenance (stage 3a of our framework) (Armitage, 2005).

Complexity

Complex actions are roughly characterised as those that feature a greater number of psychologically meaningful sub-actions, and so are more cognitively effortful to perform to completion. Behavioural complexity is thus subjective, and may be indexed by the perceived difficulty of performing the behaviour to completion (Kaushal & Rhodes, 2015; see also Chap. 5 in this volume). Complexity may shape the trajectory of habit formation, with simple actions becoming habitual more quickly (Kaushal & Rhodes, 2015). Yet, when repeated in stable circumstances, even complex behaviours can acquire habitual properties (Wood, Quinn, & Kashy, 2002).

The distinction between habitually *instigated* and *executed* behaviour is relevant here (Phillips & Gardner, 2016). A habitually instigated behaviour is one that an actor is cued to automatically commit to performing (Gardner, Phillips, & Judah, 2016). For example, 'going to the gym' is habitually instigated to the extent that an actor experiences, in response to an environmental cue, an urge to initiate a sequence she mentally represents as 'going to the gym'. Here, habit elicits behaviour by bypassing deliberation over whether to act, and may prompt the first component of the 'going to the gym' sequence (e.g. 'changing into gym shoes'). Habitually executed behaviours are those *performed* at least partly automatically; habitual execution of 'going to the gym' involves completion of one action in the sequence ('changing into gym shoes') automatically cueing another (e.g. 'walking to the door'). Habitual execution describes habit facilitating progression *through* an action sequence. For any one behaviour, an actor may have an instigation habit but not execution habit; she may carefully deliberate over whether to 'go to the gym' (no instigation habit) yet automatically perform the same actions in the same sequence in the gym (execution habit). It seems unlikely that behaviours that would be viewed as complex by many people, such as undertaking vigorous physical activity, will become both instigated and fully executed habitually. Rather, for such actions, habit may form for instigation, but successful performance may require some conscious oversight (Gardner, 2015).

A growing literature suggests that instigation habit, not execution habit, regulates behaviour frequency (Gardner et al., 2016; Hoo, Boote, Wildman, Campbell, & Gardner, 2017; Phillips & Gardner, 2016). People who are automatically triggered to 'go running' (i.e. instigation habit) will go running more consistently and frequently (Verplanken & Melkevik, 2008). The automaticity with which people progress through a 'go running' sequence, however, is unlikely to directly determine running frequency. It may not be necessary to fully automate performance to promote maintenance, because forming an instigation habit may be sufficient to maintain behaviour. Where habit formation is pursued as a mechanism for maintenance, the complexity of the behaviour—or at least, perceptions of difficulty of satisfactorily performing the action (Kaushal & Rhodes, 2015)—may be less relevant than previously thought, because instigation habit should, in theory, form equally strongly for simple and complex actions. Further research is needed to adequately test this assumption.

Reward Value

Expectation of rewarding outcomes strengthens intentions (stage 1 in our framework), and the experience of rewards prompts maintenance (stage 3a) (Rothman, 2000; Thorndike, 1911). Cue–behaviour associations may also be more quickly learned for rewarded behaviours (stage 3b) (de Wit & Dickinson, 2009). A distinction has been drawn between extrinsic rewards, derived from behaviour-contingent outcomes (e.g. financial incentives), and intrinsic rewards derived from behaviour itself (e.g. pleasure; Deci, Koestner, & Ryan, 1999). Both intrinsic and extrinsic rewards support automaticity development, but external rewarding of behaviour fosters learning of behaviour–outcome associations (Tolman, 1932), with performance becoming conditional on expected rewards. Theory suggests that extrinsic rewards will generate only *goal-directed* automatic action, whereby a cue arouses mental representation of the reward, not the goal-independent automaticity that characterises habit (Dickinson, 1985; Wood & Neal, 2007). Theory proposes that goal-directed automatic action would likely discontinue following removal or devaluation of the reward, but habitual action would not (Wood & Neal, 2009).

Intrinsic rewards hold promise for habit formation (Wiedemann, Gardner, Knoll, & Burkert, 2014). Intrinsic reward is closely linked to affect; a behaviour that generates positive or alleviates negative affect will be intrinsically rewarding. Kaushal and Rhodes (2015) found that stronger positive affective responses to exercise fostered stronger physical activity habits (see too de Bruijn et al., 2012; Wiedemann et al., 2014), suggesting that intrinsic rewards may strengthen the contribution of each performance to habit development (de Wit & Dickinson, 2009).

It can be difficult for practitioners, as external influences, to instil a behaviour with intrinsically rewarding value (but see Cooke et al., 2011). It may be more promising to target behaviours that actors are likely to find more rewarding than they expected, or behaviours that actors already find, or have previously found, inherently rewarding.

Rewards may promote habit formation, but it is unclear whether they are necessary for habit to form. Habit formation has been observed in the absence of tangible reward (Fournier et al., 2017; Lally et al., 2010). However, Lally et al.'s (2010) participants pursued self-selected behaviours, which they may have found intrinsically rewarding. Additionally, study participation itself may indicate that participants expect to derive value from the behaviour. Furthermore, mere performance of an intended action may be intrinsically rewarding (Lally & Gardner, 2013). More work is needed to understand the relationship between real-world habit formation and rewards, but it would seem prudent for intervention developers to focus on intrinsically rewarding behaviours.

Person–Related Factors

Motivation Type

As with rewards, motivation can be dichotomised into intrinsic motivation, which is driven by interest or enjoyment of action, and extrinsic motivation, driven by a desire to satisfy external demands by achieving outcomes of behaviour, such as extrinsic rewards (Deci & Ryan, 2000). Intrinsic motivation may facilitate habit formation at each of the stages set out in our framework, fostering stronger intentions (stage 1), and enabling translation of intention into sustained behaviour (stages 2 and 3a) (e.g. Hagger & Chatzisarantis, 2008). A study of multiple behaviours (e.g. playing video games, running) found that more intrinsic motivation types were associated with stronger habit, and that past behaviour was more strongly predictive of habit strength for the more intrinsically motivated, (Radel et al., 2017). Similar results were found in a study of physical activity (Gardner & Lally, 2013). These results suggest that habit associations may become stronger, or form more quickly, when rooted in intrinsically motivated action (stage 3b).

Stress and Cortisol

Stressful situations may facilitate learning of habit associations (stage 3b in our framework). Participants in one study learned associations between actions and the likelihood of receiving a pleasant drink (e.g. chocolate milk; Schwabe & Wolf, 2009). Task demands then changed, such that the pleasant drinks were no longer presented, regardless of actions taken by the participant. Participants who, prior to the learning phase, were exposed to the 'cold pressor' test—in which the hand is placed into ice water, to induce physiological stress—persisted for longer with the learned actions than those not exposed to the test (Schwabe & Wolf, 2009). Saliva samples confirmed higher cortisol, a stress hormone, among the cold pressor group.

Cortisol is thought to be conducive to habit learning because it increases use of simple stimulus–response learning over and above more cognitively sophisticated strategies (Schwabe et al., 2007). Fournier et al. (2017) found that repeating action in the morning quickened habit formation relative to performance in the evening, which they attributed to naturally raised cortisol in the morning.

Self-Control

People with stronger trait self-control—a general ability to regulate behaviour to achieve valued goals (Tangney, Baumeister, & Boone, 2004)—tend to report greater engagement in and stronger habit for 'good' behaviours, such as exercising (Adriaanse, Kroese, Gillebaart, & De Ridder, 2014; Gillebaart & Adriaanse, 2014). Teenagers reporting greater trait self-control prior to attending meditation sessions reported stronger self-reported meditation habits 3 months later than did those with lesser self-control (Galla & Duckworth, 2015, Study 5).

If self-control does contribute to habit formation, it likely does so only indirectly; people with better self-control may be better able to act on intentions, and maintain performance over time (stages 2 and 3 in our framework). There is no compelling evidence to suggest, nor a priori theoretical justification for assuming, that self-control influences habit formation over and above facilitation of behavioural repetition (stage 3b). Although studies have suggested that self-control influences behaviour via automaticity—such that people with self-control have stronger habit tendencies, which translate into more frequent performance (Adriaanse et al., 2014; Gillebaart & Adriaanse, 2014)—these have focused on ongoing behaviours, for which habit strength is likely settled, rather than on habit formation. The direction of the habit-behaviour relationship changes over time (Gardner, 2015). Studies of new behaviours capture the early, formation stage of this relationship, whereby context-dependent repetition strengthens habit. Studies of ongoing behaviours likely capture only the later stage, whereby an established habit determines performance frequency. Statistical relationships showing self-control to influence ongoing behaviours via habit conform with the view that people with greater self-control have previously formed stronger habits, which repeatedly trigger behaviour. Additionally, people with stronger trait self-control are better able to override unwanted habitual responses (De Ridder, Lensvelt-Mulders, Finkenauer, Stok, & Baumeister, 2012). These findings suggest self-control assists acting on intentions, so making people more likely to enact and sustain wanted behaviours, and better able to defend their intentions against counter-intentional habits.

Habit Substitution

Typically, new behaviours must displace or be integrated with existing actions. The goal of behaviour change is often to directly replace one action (e.g. eating high-calorie snacks) with another (eating low-calorie snacks).[5] In such instances, habit formation is more realistically depicted as substitution of a 'bad' habit with a 'good' one. Conversely, attempts to reduce engagement in ingrained behaviours may perhaps be more likely to succeed where based on displacing the unwanted action with a desired alternative (Holland, Aarts, & Langendam, 2006), rather than attempting only to inhibit the unwanted action (Adriaanse, van Oosten, de Ridder, de Wit, & Evers, 2011). Habit substitution presents both challenges and opportunities. Characteristics that render habit formation desirable for 'good' behaviours—goal-independence, automaticity, persistence—obstruct disruption of 'bad' habits (Quinn, Pascoe, Wood, & Neal, 2010). However, 'bad' habits also offer established cue–response structures that could hasten learning of new, 'good' habits.

Habit substitution can also be understood using our framework, though an actor must possess sufficient motivation (stage 1) and self-regulatory capacity (stage 2) to *both* inhibit the unwanted action *and* perform the wanted action, repeatedly (stage 3a). This should lead to both the decaying of the unwanted habit, and the development of new, stronger habit associations for the wanted action, which will override any residual memory traces of the previously habitual unwanted response in directing behaviour (stage 3b) (Walker, Thomas, & Verplanken, 2015). Where applied to habit substitution, the early phases of the formation process, depicted in formation studies as a period of considerable increases in the strength of new habitual responses (Lally et al., 2010), is in actuality a period of transitioning from an old to a new habitual response. People may perhaps require especial support to successfully negotiate the task of both inhibiting unwanted responses and performing wanted responses during this transitional phase. Potential facilitators of habit formation outlined above should nonetheless remain relevant to substitution. Habit substitution would additionally be aided by self-monitoring the unwanted behav-

[5] Breaking a habit does not necessitate formation of a new habit, but habit disruption lies outside of the scope of this chapter. Broader discussion of theory and methods around disrupting habits can be found elsewhere (e.g. Lally & Gardner, 2013; Quinn et al., 2010; Verplanken & Wood, 2006).

iour, and the settings in which it occurs ('cue monitoring'; Verhoeven, Adriaanse, de Vet, Fennis, & de Ridder, 2014), to identify likely extant cue–response associations. This would allow actors to anticipate contexts in which they must exercise most willpower to inhibit the unwanted behaviour and would also facilitate planning of desired responses to those cues (Verhoeven et al., 2014). Action planning, and formulating implementation intentions in particular, offer promise for overwriting existing habits with new associations, yet evidence of effectiveness is mixed. Some studies have found that implementation intentions are effective only where people have weak or no habit (Webb, Sheeran, & Luszczynska, 2009). One study found that implementation intentions were more effective for people with strong habits, but only where matched to participants' personal regulatory style (Tam, Bagozzi, & Spanjol, 2010). Participants inclined to focus on attaining the benefits of healthy eating responded only to implementation intentions promoting healthy snacks, whereas those focused on avoiding harm from unhealthy eating responded to implementation intentions for avoiding unhealthy snacks. More work is needed to investigate how best to harness the potential of implementation intentions for habit substitution purposes, but these findings suggest that self-regulatory strategies such as cue-monitoring and planning may be key to the success of habit substitution.

Conclusion: Directions for Future Habit Formation Research

The persistence of habitual action, independent of motivation, has made habit formation a target for interventions promoting 'good' behaviours (Rothman et al., 2009). Yet, longitudinal studies of how habit forms and factors that aid habit acquisition are scant. Conducting high-quality research in this area is challenging. It requires multiple measurements over long time periods, and participants who, prior to the study, are motivated and able to adopt a new behaviour (Kaushal & Rhodes, 2015; Lally et al., 2010), or administering interventions to motivate participants to perform such behaviours (Fournier et al., 2017; Judah et al., 2013). This demands considerable financial and time resources.

To maximise such resources, habit formation studies should use the most rigorous methods available (see the 'Habit Research in Action' box). To our knowledge, only two quantitative studies have tracked habit formation *within* individuals (Fournier et al., 2017; Lally et al., 2010). These have shown that habit typically develops asymptotically and idiosyncratically, potentially differing in rate across people, cues and behaviours. Studies that have tracked habit using scores averaged across participants are therefore problematic. Formation studies should therefore focus on within-person development. More measurement points will provide greater insight into the process. Developments in ecological momentary assessment methods, using naturalistic tools (e.g. smartphones) to capture proximal reports of habitual responses, are particularly promising (Carden & Wood, 2018). N-of-1 designs, and multi-level modelling analysis, offer potential for generating individual-level accounts of habit formation (Kwasnicka & Sniehotta, in press).

Habit development studies should also investigate influences on the formation trajectory. Our framework allows classification of such influences into stages on the path to habit formation, including development of motivation, deployment of volition to initiate and repeat behaviour, and the strengthening of cue–response associations. Processes and mechanisms of behaviour change, which are incorporated into the first three stages in our framework, are relatively well-researched. The unique contribution of our framework is its focus on development of habit associations which, in relation to meaningful human actions, has received less empirical attention. We have outlined factors that theory and empirical evidence, drawn from habit development studies and investigations of correlates of established habits, propose may facilitate habit by strengthening such associations. These can be conceptually discerned into properties of the actor, action or performance context, but in reality habit formation will likely involve interplay between all such factors (Lally et al., 2011). While practical recommendations may be drawn from our overview, our discussion offers a basis to inform the priorities of future habit formation studies. In the 'Habit Research in Action' box we outline one approach to modelling the habit formation process, which may address these priorities.

Habit Research in Action: How to Model Habit Formation and Its Determinants

Tracking habit development requires decisions about how to capture the formation process. Here, we outline the procedures Lally et al. (2010) used in a habit formation study. This paradigm enables the researcher to estimate key parameters of the formation process.

Lally et al. modelled *within-person* change because habit is an intra-individual process, based on idiosyncratic cues and behaviours, potentially forming at different rates depending on the cues, behaviours, or actors involved. Group-level data would obscure such variation. An SRHI subscale was used that seemed to best represent automaticity, which is the 'active ingredient' of habitual responding and the key indicator of habit strength. Self-report measures were most practical in this research setting, though other measures, which often require more controlled conditions, are available (see Chap. 3 in this volume). Daily measures were taken because more data points more accurately depict the habit trajectory.

Lally used non-linear modelling methods to track individual automaticity changes daily on up to 84 occasions (7 days × 12 weeks, though some participants did not respond at all timepoints). Figure 12.2 displays data for three participants. Participant-specific curve parameters were compared to estimate between-person differences see Fournier, d'Arripe-Longueville, & Radel, (2017) for a similar approach. Lally et al. fitted a curve to each participant's scores over time, estimating habit strength using the equation $y = a - be^{-cx}$,

(continued)

where '*y*' represents automaticity (habit), and '*x*' the day of the study. ('*x*' should reflect the *n*th repetition of a behaviour but, for those who performed the behaviour once daily as instructed, *x* is equivalent to study day.) The constant '*a*' represents the asymptote (i.e. the point at which automaticity plateaus), '*b*' the difference between the asymptote and the modelled automaticity score when $x = 0$ (i.e. increase in automaticity from baseline), and '*c*' a constant, representing the rate at which maximum automaticity was reached. Time to reach 95% of the asymptote was used to indicate time required for habit to peak. (It is mathematically impossible to calculate time to reach 100% of the asymptote value). Model fit was estimated from model R^2 values for each participant.

These statistical procedures can be run using the sequential quadratic programming estimation method in SPSS. Data must be organised with each assessment point on a separate row, and the file split by participant. Starting values must be chosen for each constant. These will depend on the chosen habit measurement; we recommend a scale starting at 0. The model must be constrained such that constants are positive. To calculate the time to reach 95% of the asymptote, the equation $-ln(a/20b)/c$ must be used, entering values of '*a*', '*b*', and '*c*' estimated by the model. This generates comparable statistics for each participant.

Asymptote scores ('*a*'), and the time to 95% of the asymptote can be used to explore hypothesised moderators. For example, a study of the impact of rewards might compare the level at which habit peaks ('*a*') and the time to reach 95% asymptote level between individuals that receive rewards and those who do not.

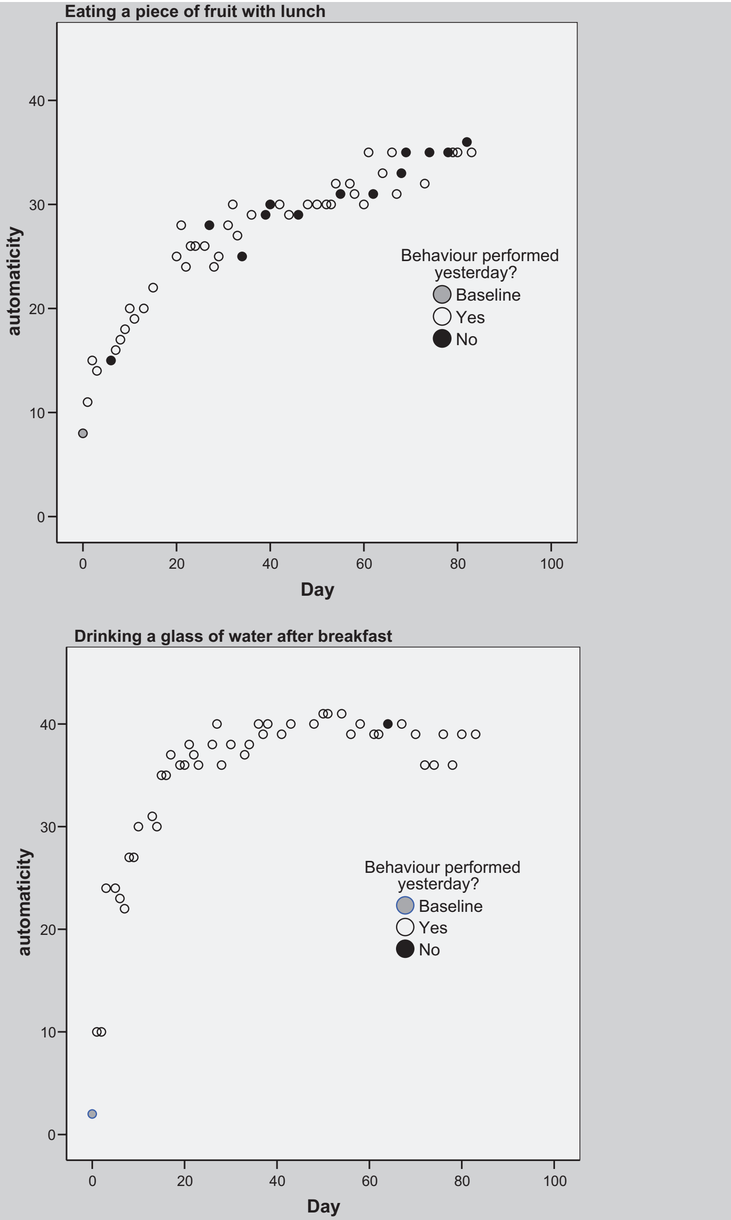

Fig. 12.2 Six examples of increases in automaticity scores during the 84 days of Lally et al.'s (2010) study. The first three examples show whether participants performed their chosen behaviour the previous day. The latter three examples show raw scores and a growth curve modelled using non-linear regressions. (Images reproduced with permission of John Wiley and Sons)

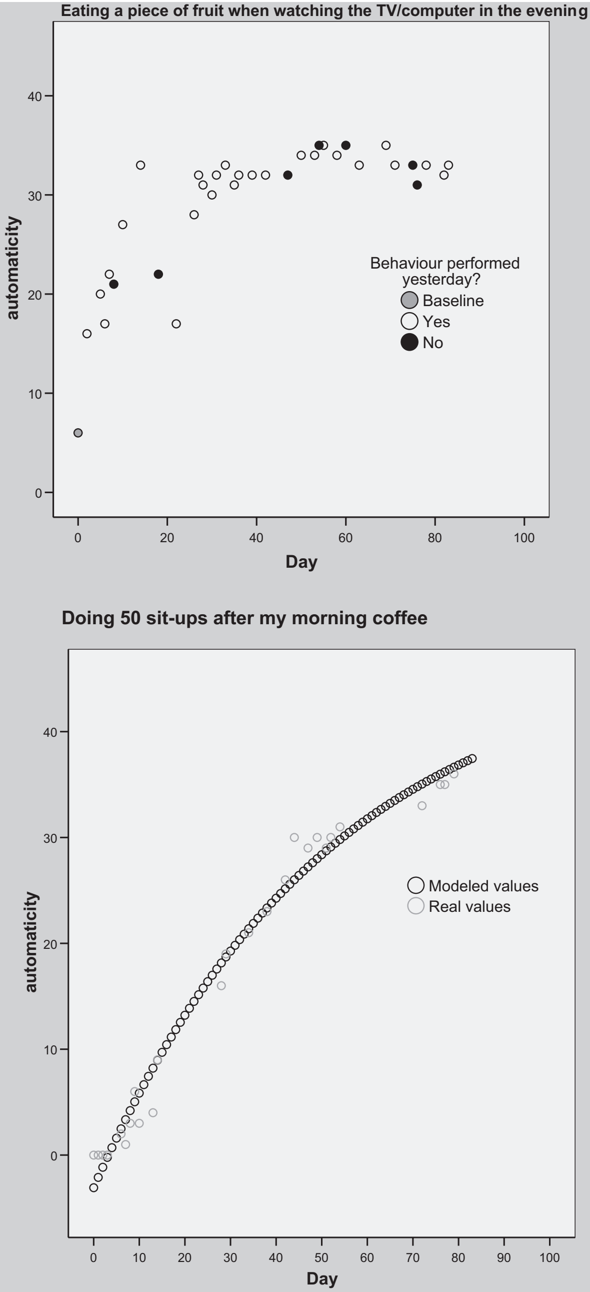

Fig. 12.2 (continued)

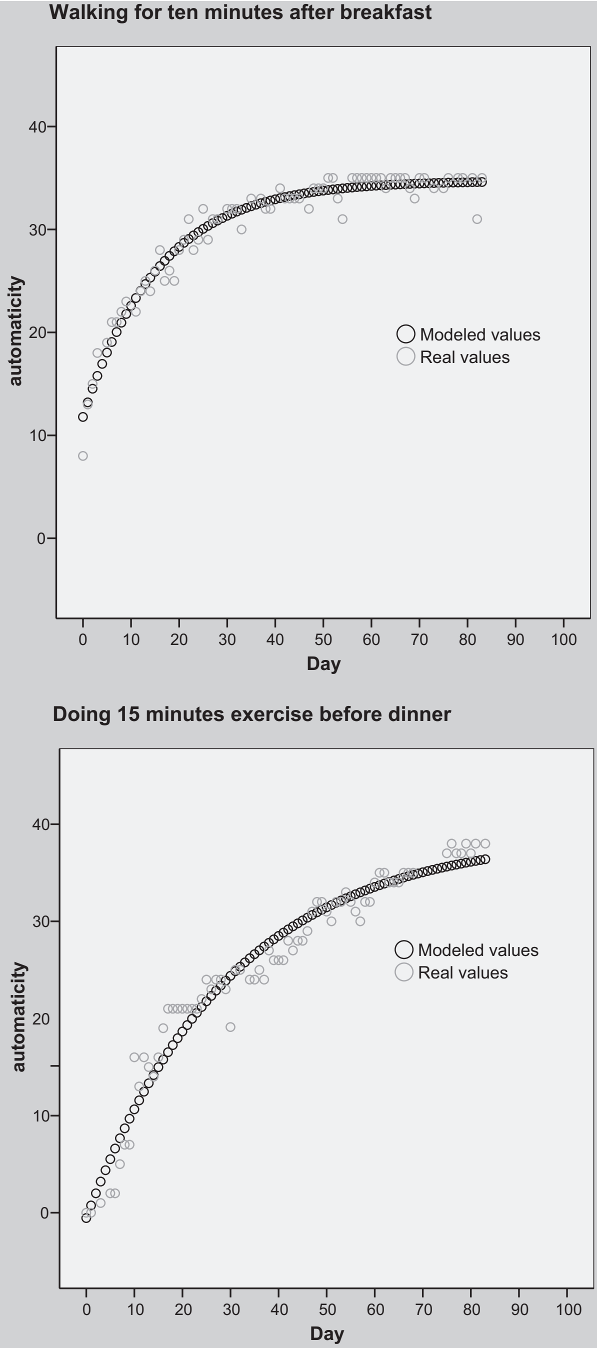

Fig. 12.2 (continued)

References

Adriaanse, M. A., Kroese, F. M., Gillebaart, M., & De Ridder, D. T. D. (2014). Effortless inhibition: Habit mediates the relation between self-control and unhealthy snack consumption. *Frontiers in Psychology, 5*, 444.

Adriaanse, M. A., van Oosten, J. M. F., de Ridder, D. T. D., de Wit, J. B. F., & Evers, C. (2011). Planning what not to eat: Ironic effects of implementation intentions negating unhealthy habits. *Personality and Social Psychology Bulletin, 37*, 69–81.

Armitage, C. J. (2005). Can the theory of planned behavior predict the maintenance of physical activity? *Health Psychology, 24*, 235–245.

Bailey, B. P., & Konstan, J. A. (2006). On the need for attention-aware systems: Measuring effects of interruption on task performance, error rate, and affective state. *Computers in Human Behavior, 22*, 685–708.

Blaszczynski, A., & Nower, L. (2002). A pathways model of problem and pathological gambling. *Addiction, 97*, 487–499.

Botvinick, M. M., & Bylsma, L. M. (2005). Distraction and action slips in an everyday task: Evidence for a dynamic representation of task context. *Psychonomic Bulletin & Review, 12*, 1011–1017.

Cantor, N., & Blanton, H. (1996). Effortful pursuit of personal goals in daily life. In P. M. Gollwitzer & J. A. Bargh (Eds.), *The psychology of action: Linking cognition and motivation to behavior* (pp. 338–359). New York: Guilford Press.

Carden, L., & Wood, W. (2018). Habit formation and change. *Current Opinion in Behavioral Sciences, 20*, 117–122.

Cooke, L. J., Chambers, L. C., Añez, E. V., Croker, H. A., Boniface, D., Yeomans, M. R., et al. (2011). Eating for pleasure or profit: The effect of incentives on children's enjoyment of vegetables. *Psychological Science, 22*, 190–196.

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

Danaei, G., Ding, E. L., Mozaffarian, D., Taylor, B., Rehm, J., Murray, C. J., et al. (2009). The preventable causes of death in the United States: Comparative risk assessment of dietary, lifestyle, and metabolic risk factors. *PLoS Medicine, 6*, e1000058.

de Bruijn, G. J., Rhodes, R. E., & van Osch, L. (2012). Does action planning moderate the intention-habit interaction in the exercise domain? A three-way interaction analysis investigation. *Journal of Behavioral Medicine, 35*, 509–519.

De Ridder, D. T. D., Lensvelt-Mulders, G., Finkenauer, C., Stok, F. M., & Baumeister, R. F. (2012). Taking stock of self-control: A meta-analysis of how trait self-control relates to a wide range of behaviors. *Personality and Social Psychology Review, 16*, 76–99.

de Wit, S., & Dickinson, A. (2009). Associative theories of goal-directed behaviour: A case for animal-human translational models. *Psychological Research, 73*, 463–476.

Deci, E. L., Koestner, R., & Ryan, R. M. (1999). A meta-analytic review of experiments examining the effects of extrinsic rewards on intrinsic motivation. *Psychological Bulletin, 125*, 627–668.

Deci, E.L., & Ryan, R.M. (2000). The ''what'' and ''why'' of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry*, 11, 227–268.

Dickinson, A. (1985). Actions and habits: The development of behavioural autonomy. *Philosophical Transactions of the Royal Society of London. Series B. Biological Sciences, 308*, 67–78.

Dombrowski, S. U., Knittle, K., Avenell, A., Araújo-Soares, V., & Sniehotta, F. F. (2010). Long-term maintenance of weight loss with non-surgical interventions in obese adults: Systematic review and meta-analyses of randomized controlled trials. *BMJ, 348*, g2646.

Fleig, L., Pomp, S., Parschau, L., Barz, M., Lange, D., Schwarzer, R., et al. (2013). From intentions via planning and behavior to physical exercise habits. *Psychology of Sport and Exercise, 14*, 632–639.

Fournier, M., d'Arripe-Longueville, F., & Radel, R. (2017). Testing the effect of text messaging cues to promote physical activity habits: A worksite-based exploratory intervention. *Scandinavian Journal of Medicine and Science in Sports, 27*, 1157–1165.

Fournier, M., d'Arripe-Longueville, F., Rovere, C., Easthope, C. S., Schwabe, L., El Methni, J., et al. (2017). Effects of circadian cortisol on the development of a health habit. *Health Psychology, 36*, 1059–1064.

Galla, B. M., & Duckworth, A. L. (2015). More than resisting temptation: Beneficial habits mediate the relationship between self-control and positive life outcomes. *Journal of Personality and Social Psychology, 109*, 508–525.

Gardner, B. (2015). A review and analysis of the use of 'habit' in understanding, predicting and influencing health-related behaviour. *Health Psychology Review, 9*, 277–295.

Gardner, B., Abraham, C., Lally, P., & de Bruijn, G.-J. (2012). Towards parsimony in habit measurement: Testing the convergent and predictive validity of an automaticity subscale of the self-report habit index. *International Journal of Behavioural Nutrition and Physical Activity, 9*, 102.

Gardner, B., de Bruijn, G. J., & Lally, P. (2011). A systematic review and meta-analysis of applications of the self-report habit index to nutrition and physical activity behaviours. *Annals of Behavioural Medicine, 42*, 174–187.

Gardner, B., & Lally, P. (2013). Does intrinsic motivation strengthen physical activity habit? Modeling relationships between self-determination, past behaviour and habit strength. *Journal of Behavioral Medicine, 36*, 488–497.

Gardner, B., Phillips, L. A., & Judah, G. (2016). Habitual instigation and habitual execution: Definition, measurement, and effects on behaviour frequency. *British Journal of Health Psychology, 21*, 613–630.

Gillebaart, M., & Adriaanse, M. A. (2014). Self-control predicts exercise behavior by force of habit, a conceptual replication of Adriaanse et al (2014). *Frontiers in Psychology, 8*, 190.

Gillie, T., & Broadbent, D. (1989). What makes interruptions disruptive? A study of length, similarity, and complexity. *Psychological Research, 50*, 243–250.

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

Hagger, M. S., & Chatzisarantis, N. (2008). Self-determination theory and the psychology of exercise. *International Review of Sport and Exercise Psychology, 1*, 79–103.

Heckhausen, H., & Kuhl, J. (1985). From wishes to action: The dead ends and short-cuts on the long way to action. In M. Frese & J. Sabini (Eds.), *Goal-directed behaviour: The concept of action in psychology* (pp. 134–159). Hillsdale, NJ: Erlbaum.

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.

Hoo, Z. H., Boote, J., Wildman, M. J., Campbell, M. J., & Gardner, B. (2017). Determinants of objective adherence to nebulised medications among adults with cystic fibrosis: An exploratory mixed methods study comparing low and high adherers. *Health Psychology and Behavioral Medicine, 5*, 299–316.

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

Judah, G., Gardner, B., & Aunger, R. (2013). Forming a flossing habit: An exploratory study of the psychological determinants of habit formation. *British Journal of Health Psychology, 18*, 338–353.

Kaushal, N., & Rhodes, R. E. (2015). Exercise habit formation in new gym members: A longitudinal study. *Journal of Behavioural Medicine, 38*, 652–663.

Klöckner, C., & Oppedal, I. O. (2011). General vs. domain specific recycling behaviour—applying a multilevel comprehensive action determination model to recycling in Norwegian student homes. *Resources, Conservation and Recycling, 55*, 463–471.

Kwasnicka, D., Dombrowski, S. U., White, M., & Sniehotta, F. F. (2016). Theoretical explanations for maintenance of behaviour change: A systematic review of behaviour theories. *Health Psychology Review, 10*, 277–296.

Kwasnicka, D., & Sniehotta, F. F. (in press). The role of habit formation in behaviour change maintenance processes: A theoretical perspective. In B. Verplanken (Ed.), *The psychology of habit*. Berlin: Springer.

Lally, P., & Gardner, B. (2013). Promoting habit formation. *Health Psychology Review, 7*(Suppl 1), S137–S158.

Lally, P., van Jaarsveld, C. H. M., Potts, H. W. W., & Wardle, J. (2010). How are habits formed: Modelling habit formation in the real world. *European Journal of Social Psychology, 40*, 998–1009.

Lally, P., Wardle, J., & Gardner, B. (2011). Experiences of habit formation: A qualitative study. *Psychology, Health & Medicine, 16*, 484–489.

McDaniel, M. A., & Einstein, G. O. (2000). Strategic and automatic processes in prospective memory retrieval: A multiprocess framework. *Applied Cognitive Psychology, 14*, S127–S144.

Michie, S., van Stralen, M. M., & West, R. (2011). The behaviour change wheel: A new method for characterising and designing behaviour change interventions. *Implementation Science, 6*, 42.

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

Neal, D. T., Wood, W., Labrecque, J. S., & Lally, P. (2012). How do habits guide behavior? Perceived and actual triggers of habits in daily life. *Journal of Experimental Social Psychology, 48*, 492–498.

Neal, D. T., Wood, W., Wu, M., & Kurlander, D. (2011). The pull of the past: When do habits persist despite conflict with motives? *Personality and Social Psychology Bulletin, 37*, 1428–1437.

Orbell, S., & Verplanken, B. (2010). The automatic component of habit in health behavior: Habit as cue-contingent automaticity. *Health Psychology, 29*, 374–383.

Phillips, L. A., & Gardner, B. (2016). Habitual exercise instigation (vs. execution) predicts healthy adults' exercise frequency. *Health Psychology, 35*, 69–77.

Pimm, R., Vandelanotte, C., Rhodes, R. E., Short, C., Duncan, M., & Rebar, A. L. (2016). Cue consistency associated with physical activity automaticity and behavior. *Behavioral Medicine, 42*, 248–253.

Prochaska, J. O., & DiClemente, C. C. (1983). Stages and processes of self-change of smoking: Toward an integrative model of change. *Journal of Consulting and Clinical Psychology, 51*, 390–395.

Quinn, J. M., Pascoe, A., Wood, W., & Neal, D. T. (2010). Can't control yourself? Monitor those bad habits. *Personality and Social Psychology Bulletin, 36*, 499–511.

Radel, R., Pelletier, L., Pjevac, D., & Cheval, B. (2017). The links between self-determined motivations and behavioral automaticity in a variety of real-life behaviours. *Motivation and Emotion, 41*, 443–454.

Rebar, A., Rhodes, R.E., & Gardner, B. (2018) How we are misinterpreting physical activity intention-behavior relations and what to do about it. Manuscript submitted for publication.

Rothman, A. J. (2000). Toward a theory-based analysis of behavioral maintenance. *Health Psychology, 19*(Suppl 1), 64–69.

Rothman, A. J., Sheeran, P., & Wood, W. (2009). Reflective and automatic processes in the initiation and maintenance of dietary change. *Annals of Behavioral Medicine, 38*(Suppl 1), S4–S17.

Schüz, B., Sniehotta, F. F., Wiedemann, A., & Seemann, R. (2006). Adherence to a daily flossing regimen in university students: Effects of planning when, where, how and what to do in the face of barriers. *Journal of Clinical Periodontology, 33*, 612–619.

Schwabe, L., Oitzl, M. S., Philippsen, C., Richer, S., Bohringer, A., Wippich, W., et al. (2007). Stress modulates the use of spatial versus stimulus-response learning strategies in humans. *Learning and Memory, 14*, 109–116.

Schwabe, L., & Wolf, O. T. (2009). Stress prompts habit behavior in humans. *Journal of Neuroscience, 29*, 7191–7198.

Strack, F., & Deutsch, R. (2004). Reflective and impulsive determinants of social behavior. *Personality and Social Psychology Review, 8*, 220–247.

Tam, L., Bagozzi, R. P., & Spanjol, J. (2010). When planning is not enough: The self-regulatory effect of implementation intentions on changing snacking habits. *Health Psychology, 29*, 284–292.

Tangney, J. P., Baumeister, R. F., & Boone, A. L. (2004). High self-control predicts good adjustment, less pathology, better grades, and interpersonal success. *Journal of Personality, 72*, 271–324.

Thorndike, E. L. (1911). *Animal intelligence* (2nd ed.). New York: Hafner.

Tolman, E. C. (1932). *Purposive behavior in animals and men*. New York: Appleton-Century-Crofts.

Vallacher, R. R., & Wegner, D. M. (1987). What do people think they're doing? Action identification and human behaviour. *Psychological Review, 94*, 3–15.

Verhoeven, A. A., Adriaanse, M. A., de Vet, E., Fennis, B. M., & de Ridder, D. T. (2014). Identifying the 'if' for 'if-then' plans: Combining implementation intentions with cue-monitoring targeting unhealthy snacking behaviour. *Psychology and Health, 29*, 1476–1492.

Verplanken, B. (2005). Habits and implementation intentions. In J. Kerr, R. Weitkunat, & M. Moretti (Eds.), *The ABC of behavioural change* (pp. 99–109). Oxford: Elsevier Science.

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

Verplanken, B., & Melkevik, O. (2008). Predicting habit: The case of physical exercise. *Psychology of Sport and Exercise, 9*, 15–26.

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 and Marketing, 25*, 90–103.

Walker, I., Thomas, G. O., & Verplanken, B. (2015). Old habits die hard: Travel habit formation and decay during an office relocation. *Environment and Behavior, 47*, 1089–1106.

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

Webb, T. L., & Sheeran, P. (2007). How do implementation intentions promote goal attainment? A test of component processes. *Journal of Experimental Social Psychology, 43*, 295–302.

Webb, T. L., Sheeran, P., & Luszczynska, A. (2009). Planning to break unwanted habits: Habit strength moderates implementation intention effects on behaviour change. *British Journal of Social Psychology, 48*, 507–523.

Wiedemann, A. U., Gardner, B., Knoll, N., & Burkert, S. (2014). Intrinsic rewards, fruit and vegetable consumption, and habit strength: A three-wave study testing the Associative-Cybernetic Model. *Applied Psychology: Health and Well-Being, 6*, 119–134.

Wood, W., Labrecque, J. S., Lin, P.-Y., & Rünger, D. (2015). Habits in dual process models. In J. W. Sherman, B. Gawronski, & Y. Trope (Eds.), *Dual-process theories of the social mind* (pp. 371–385). London: Guilford Press.

Wood, W., & Neal, D. T. (2007). A new look at habits and the habit-goal interface. *Psychological Review, 114*, 843–863.

Wood, W., & Neal, D. T. (2009). The habitual consumer. *Journal of Consumer Psychology, 19*, 579–592.

Wood, W., Quinn, J. M., & Kashy, D. A. (2002). Habits in everyday life: Thought, emotion, and action. *Journal of Personality and Social Psychology, 83*, 1281–1297.

Wood, W., & Rünger, D. (2016). Psychology of habit. *Annual Review of Psychology, 67*, 11.1–11.26.

Chapter 13
Using N-of-1 Methods to Explore Habit Formation

Dominika Kwasnicka, Beatrice M. Konrad, Ian M. Kronish, and Karina W. Davidson

Introduction

We are in the midst of a long-standing public health crisis that is driven at least in part by a failure to change health behaviours and form healthy habits (Mokdad, Marks, Stroup, & Gerberding, 2004; Spring et al., 2013). The between-person randomized controlled trial (RCT) approach to behaviour change science and intervention has only succeeded in slowing down this trend (Norman, 2008). This failure is in part because RCTs are not well suited to account for the substantial between-person variations in the complex, multifactorial, dynamic processes relevant to habit formation underlying health behaviours.

Recognition is growing, based on statistical, methodological, and empirical grounds, of issues with the use of between-person designs to test habit theories and behavioural interventions because habits are usually highly personal (Lally, Van Jaarsveld, Potts, & Wardle, 2010). Thus, there has been a call to test the theories of health behaviour change, including habit theories, and their derived techniques, such as habit formation, in a more personalized, within-person (N-of-1) approach (Johnston & Johnston, 2013). Such testing is part of an effort to understand predictors unique to person's behaviour as well as individual responsiveness to behaviour change interventions (Michie & Johnston, 2012). N-of-1 methods may be better equipped than between-person designs for studying the effects of habit formation and other interventions aimed at helping individuals form healthy habits.

In this chapter, we briefly examine the limitations of the current conventional between-person RCT designs used to evaluate behaviour change interventions. We

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then introduce within-person N-of-1 designs, including both observational studies and randomized N-of-1 trials. These designs represent innovative approaches to identifying interventions that have a potential to help us tackle public health behavioural problems, such as obesity and sedentary lifestyle, and for increasing the precision of interventions for habit formation.

The Between-Person Approach Versus Within-Person Approach for Studying Health Behaviour

The between-person RCT study design is an approach concerned with deriving generalizable laws, or laws "common to all" (Lamiell, 1998). A conventional between-person RCT is commonly regarded at the top of the evidence pyramid for evaluating whether an intervention is beneficial relative to a control or comparator condition (Sackett, Sharon, & Richardson, 2000). Although health behaviour interventions might appear immune from producing adverse effects, some presumably innocuous behavioural interventions, such as cognitive behavioural therapy or social support in cardiac patients, have demonstrated the potential for harm (Fig. 13.1), including increased cardiovascular events or death (Berkman et al., 2003; Frasure-Smith et al., 2002; Hall, Tuskell, Vila, & Duffy, 1992; Jakicic et al., 2016).

Conventional RCTs provide between-person differences that estimate the treatment effect in an *average* person. In clinical practice and in behavioural science, we apply this knowledge to predict how a *specific* person will respond to the intervention. However, applying results from a conventional RCT design that obtained and reported on between-person differences assumes that the average response of the proposed intervention is sufficiently generalizable to the expected response of the individual person. Yet, this assumption is not valid for many interventions, particularly those directed at health behaviour change, such as habit formation interventions. The effec-

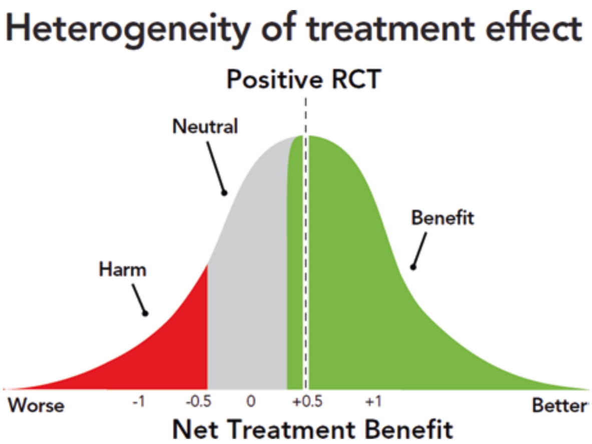


Fig. 13.1 The average participant in an RCT, at the centre of the distribution, has a net treatment benefit of modest-to-moderate effect size (Cohen's $d = 0.5$). At the tails of the curve, some participants have even more benefit, but other participants have a neutral effect from the intervention, or even at the extreme tail, experience harm

tiveness of specific behavioural interventions often vary widely between individuals (Fernandez, Nguyen, Duan, Gabler, & Kravitz, 2010).

The complementary approach to the between-person RCT is a *within-person* approach that allows researchers to specify and explain more unique and often subjective phenomena such as personal habits. N-of-1 studies examine one participant (Duan, Kravitz, & Schmid, 2013), they can involve observational N-of-1 design and N-of-1 trials. In observational N-of-1 studies individuals will perform rigorous monitoring over time to identify personal predictors or triggers of health behaviours or symptoms. N-of-1 observational studies are repeated within-person observations that do not include any manipulation in terms of random allocation to study conditions. Instead the participants' associations of predictor and outcome variables are assessed within participants, rather than between participants.

The method applied in N-of-1 studies involves repeated self-assessment of the study participants or the repeated collection of multiple data points (e.g., continuous data such as heart rate or physical activity monitoring) across time under changing conditions. Ecological momentary assessment (EMA) is one such method that is often used to explore predictor variables, behaviours, and behavioural outcomes in N-of-1 observational studies. By using methods such as these, retrospective data collection biases (e.g., recall bias) can be avoided. Data can be collected using a variety of instruments, including self-report questionnaires (e.g., Verplanken & Orbell, 2003) using paper-and-pen or smartphone diaries, as well as physiological, biological, and observed behaviour via mobile phones or other mobile health devices.

N-of-1 RCTs are cross-over experiments conducted with one participant acting as their own control. N-of-1 RCTs are designed to include a sufficient number of treatment/intervention cross-over periods in order to minimise the influence of confounding by time-effects and to provide enough data to establish the impact of a given intervention on the outcome of interest. An example of an N-of-1 RCT relevant to health behaviour change would be a cross-over trial where participants are presented with random blocks of 5 days when a certain contextual cue *is* versus *is not* present in their environment. We provide more detailed discussions and examples of N-of-1 observational studies and N-of-1 RCTs throughout the rest of this chapter and demonstrate how N-of-1 method can be used to explore habit formation.

Rationale for Using N-of-1 Methods for Exploring Habit Formation Theory

Most health psychology theories apply to individuals, and not to groups of individuals. Thus, within-person designs can be used to test if the theories are supported at the individual level (Johnston & Johnston, 2013); that is N-of-1 method can be used to test the predictions of habit formation theories. For example, habit formation theory (e.g., Ouellette & Wood, 1998) proposes that the repeated pairing of the new behaviour with *a consistent context/contextual cues,* leads to automaticity, the hypothesized mechanism of action for habit formation. Using N-of-1 designs, we could determine whether automaticity operates differently in different people. More

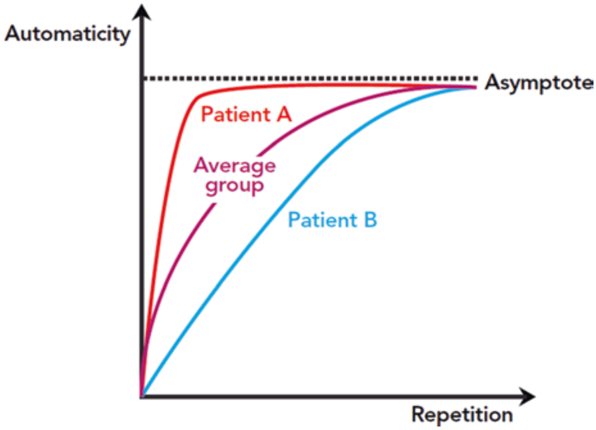


Fig. 13.2 Predicted increase in automaticity (an asymptotic curve)—individual participants versus the mean

specifically, N-of-1 can be used to determine if there is heterogeneity or variance in the association of a consistent context with the extent of automaticity. N-of-1 designs could also address why these differences exist—under which circumstances and for whom—by running the same N-of-1 design on many people, and testing which people develop automaticity in similar ways, and which people develop automaticity in unique ways.

Figure 13.2 shows a theoretical association between habit automaticity and repetition of a health behaviour in a consistent context. In this figure participant A may require fewer repetitions, and participant B may require more repetitions than does the average of the group to reach an asymptote on habit automaticity. Such a finding (that individuals A and B require vastly different numbers of behaviour repetitions in the same context but can both reach automaticity) would be consistent with the original formulation of the theory but is more appropriately tested by a within-person, N-of-1 observational design. Following multiple N-of-1 observations, one could examine the heterogeneity of dose automaticity, and then examine different phenotypes for quick and slow automaticity plateau attainment. Lally et al. (2010) produced similar individual habit formation curves which can also be described mathematically, i.e. the steepness of the slope (i.e. how fast does a behaviour become automatic) and the level of the asymptote (i.e., how automatic a behaviour can become); they can be generated for each person participating in the within-person study for each investigated behaviour or behavioural outcome (see also Chap. 12 in this volume).

N-of-1 Observational Design: Opportunities for Understanding Habit Formation

Recent technological developments give us new opportunities for testing within-person hypotheses in observational N-of-1 studies. Data about habitual health behaviours can often be captured unobtrusively or even covertly without the active involvement of the study participants. For example, we can determine where a particular person habitually shops on the basis of their geo-location and we can assess the nutritional value of the products they buy on the basis of their store reward cards. With the use of such methods, observational N-of-1 studies can form a first step before delivering personalized interventions. The results of individual observational N-of-1 studies can also be pooled to understand which habit predictors are common across study participants and which vary widely between individuals. To illustrate this point, we present two habit-related case studies that operationalize N-of-1 observational design.

Case Study 1: N-of-1 Observational Study Evaluating Predictors of Weight Loss Maintenance

We recently conducted an N-of-1 study investigating weight loss maintenance, evaluating predictors of weight loss at the individual level (Kwasnicka, Dombrowski, White, & Sniehotta, 2017). Our participants were asked to monitor daily their physical activity levels (with activity monitors), their weight (with Wi-Fi connected scales), and to fill in daily surveys regarding the predictors and outcomes associated with weight loss maintenance (using smartphone EMA surveys). The results showed that participants who had recently lost weight had differing patterns of predicting variables for habitual physical activity, adherence to a weight loss plan, and weight change. Each study participant had a different set of predictors (variables that significantly corresponded with weight outcomes). We then compared the individual-level findings across participants concluding that, for most participants, not following their routine and changes in their environment were associated with disruptions in their weight loss maintenance. However, this pattern was not the same in all participants, we found that some participants developed strategies to adjust their weight loss behaviours in new environments. Thus, our findings suggested that different groups of participants need to be provided with different habit formation advice for weight loss.

Case Study 2: N-of-1 Observational Study of the Relationship Between Stress and Exercise

We also recently conducted an N-of-1 observational study in 79 intermittently exercising adults comparing the association between stress and bouts of exercise across 1 year using activity monitors and smartphone EMA surveys (Burg et al., 2017). Here, we demonstrated that while stress decreased the likelihood of an exercise bout[1] in most participants, in others, stress actually increased the likelihood of

[1] I.e., a consecutive 30 min period with at least 24 min of moderate or vigorous physical activity.

an exercise bout. In a separate analysis of the same sample, we also compared within- and between-person machine learning approaches to identifying predictors of bouts of exercise (Davidson & Cheung, 2017). Here, we found that N-of-1 approach improved the correct prediction as to whether participants were likely to exercise. We found that an N-of-1 approach correctly classified 75% of the exercise bouts, based on unique or within-person predictors, while the between-person approach only correctly classified 64% of the exercise bouts, based on between-person predictors. Exploring the individual-level decision tree model, we found that for some participants, weather above 21 °C (70 °F) predicted decreased probability of an exercise bout; for others, weather above 21° predicted an increased probability of an exercise bout. Understanding the within-person predictors was more useful than knowing the 'average' predictors. Similar to the weight loss study, our results showed that personalized advice to maintain diet and/or exercise habits likely will differ substantially between participants; therefore, patterns of behaviour in each person could be explored to then accurately tailor habit-relevant interventions.

N-of-1 Trial Design: Opportunities for Assessing Habit Interventions

The focus of this chapter so far has been using N-of-1 observational methods to explore and identify predictors or triggers of individual behaviour to understand habit formation. N-of-1 methods can also be used to compare the effect of behaviour change interventions within individuals. N-of-1 trials are experiments conducted on one person (Murad, Asi, Alsawas, & Alahdab, 2016). Designing robust N-of-1 trials entails assigning the individual participant to a sequence of two or more conditions randomized over time; keeping the participant and the intervention provider blinded, whenever possible, to which condition is offered.

In the N-of-1 trial, design issues are carefully considered a priori to ensure one is making treatment decisions based on high-quality evidence that accounts for the dynamic properties of the intervention (e.g., 'run-in' and 'washout' periods). A run-in period is a period before a clinical trial is commenced, and a washout period is the removal of an intervention to allow its effects to dissipate and statistical considerations (e.g., sufficient measurements to identify statistically significant differences in treatment effects). Thus, these designs utilize many of the strengths of conventional RCTs such as blinding and randomization, and incorporate them into multiple crossover trials conducted on single individuals (Guyatt et al., 1986).

N-of-1 trials also consider issues such as balanced sequence assignment and repetition to ensure results are valid. In well-designed N-of-1 trials, off-target effects are assessed ecologically and in real time, which reduces the potential for biased reporting (Shiffman, Stone, & Hufford, 2008). The N-of-1 trial can systematically test multiple treatments at the outset to learn which one best gets participants to the goal,

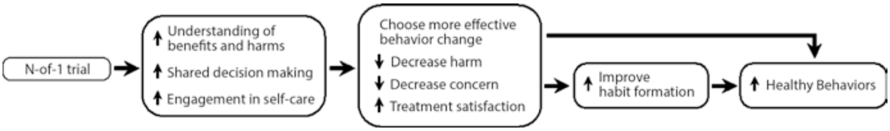
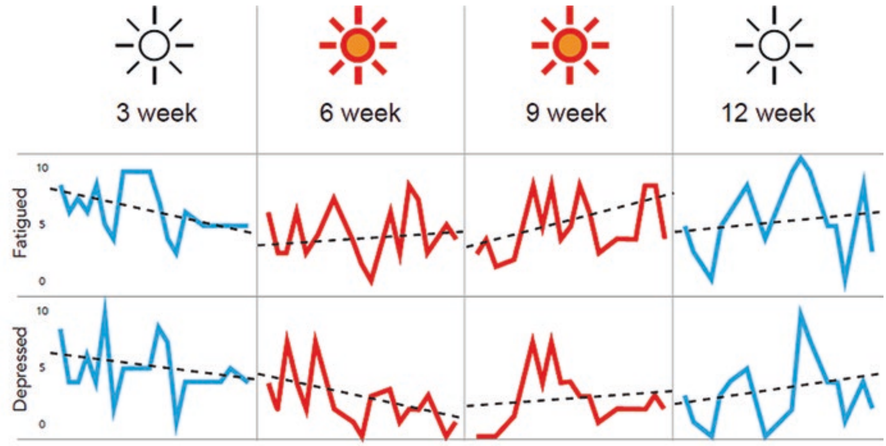


Fig. 13.3 Conceptual model for how participation in an N-of-1 trial can achieve more successful behaviour change

e.g., multiple cross-over habit formation interventions. In N-of-1 trials, participants play a central role in decision-making, and treatment decisions are customized according to first-hand knowledge about benefits and harms learned over the course of the trial, which in turn, leads to increased confidence and satisfaction in treatments and, in the case of behaviour change interventions, more successful and longstanding behaviour change (Fig. 13.3). To show the applicability of the N-of-1 trial design to studying behaviour change interventions at the individual level that rely on habit formation, we present a case study of applying an N-of-1 trial to depression management cases and N-of-1 factorial RCT testing different behaviour change techniques in older adults to increase walking.

Case Study 3: N-of-1 Trial of Light Therapy for Depressive Symptoms in Cancer Survivors

Our third N-of-1 trial case study involved an N-of-1 trial evaluating a non-pharmacologic treatment for depressive symptoms in cancer survivors. We sought to determine whether an emerging alternative therapy for depression that highly relies on habit formation—bright light therapy—could be effective in such participants. We designed an N-of-1 trial in which participants compared bright light therapy with a sham. Although results were available from small studies for estimating the onset period for treatment effects at a group level, we had little understanding of the needed onset and offset periods at a person level. Similarly, we had little knowledge of heterogeneity of treatment effects. In our first N-of-1 trial (Fig. 13.4) the results showed that contrary to expectations based on average treatment effects in other groups of cancer survivors, bright light therapy was associated with worse depressive symptoms than dim red light sham therapy (−1.4 points lower on a 10-point scale, $p = .03$). Additional N-of-1 trials of light therapy in this population are underway; however, these data highlight the importance of testing intervention effects in individual participants through N-of-1 trials. Participants will not adhere to light therapy, or other recommended behavioural treatments, if their results are worse after treatment. Establishing the optimal treatment first, and then working on habit formation, is likely to improve the treatment adherence and intervention success.



	Model 1: Regression	Model 2: Regression adjusted for linear time trend	Model 3: Regression adjusted for auto-correction	Model 4: Regression adjusted for auto-correction and linear time trends
Difference in Mood VAS score: Red v Bright White (range: 0-10)	-1.53 p=0.004	-1.43 p=0.006	-1.50 p=0.02	-1.41 p=0.03
Linear trend	-	-0.48 p=0.04	-	-0.49 p=0.08
Auto-correction*	-	-	0.24	0.21

Fig. 13.4 Data from cancer survivor conducting N-of-1 trial of bright white light versus dim red light for treatment of depressive symptoms. Depressive symptoms were modestly lower during the dim-red-light therapy time periods. Several different approaches to testing for the significance of differences in symptoms were applied including models that presumed a linear trend and models that accounted for possible autocorrelation between data that was collected on adjacent days

Case Study 4: N-of-1 Trial of Behaviour Change Techniques for Increasing Walking Among Older People

We also conducted an N-of-1 RCT to compare goal setting and self-monitoring to increase walking among older people in eight adults 60–87 years old (Nyman et al., 2016). The participants were randomly allocated to a 2 (goal-setting vs. active control) × 2 (self-monitoring vs. active control) factorial RCT over 62 days. The study aim was to test the effectiveness of these techniques for increasing walking within individuals. Data was analysed using time series for each single case using linear regression. Compared to control days, goal-setting increased walking in 4 out of 8 participants and self-monitoring increased walking in 7 out of 8 participants.

Walking is usually considered a habitual activity and several interventions aim to promote walking; the behavioural interventions that appear effective on average, often do not show within person effects. Therefore, careful investigation of the most suitable behaviour change techniques that promote habit formation within individuals is needed to better understand how to promote habitual behaviours.

Designing Robust N-of-1 Trials and Applying N-of-1 Trial Approach to Habit Theories

If habit formation is to be optimized for each participant, intervention providers need to identify the most suitable contexts and interventions to form a habit through N-of-1 trials; they need to also understand when they can use an N-of-1 trial, and when it is inappropriate. Many assumptions and requirements must be met to consider an N-of-1 trial approach. In this section, we discuss the preconditions needed in order to use N-of-1 trial design to evaluate a treatment. First, the target behaviours or health conditions must occur across time and must be amenable to change. If the targeted behaviour is intermittent or episodic (e.g., carrying/using asthma inhaler), then it must occur often enough so that the response to treatments (e.g., number of inhaler use episodes) can feasibly be measured over time. If episodes are too far apart, then it will be impractical to have treatment periods that are sufficiently long to provide a large enough sample size to arrive at confident conclusions about within-person differences in treatment effects.

Furthermore, the intervention to be tested in the N-of-1 trial must be able to be withdrawn and so must be reversible, i.e., treatment 1 should not influence treatment 2; however, in terms of habit formation interventions the effects of the intervention are often (intentionally) not reversible. The intervention provider should also understand the onset and washout periods to determine the required time during and between exposures to the intervention, in order to set the time for each crossover period. In many cases, having a credible placebo intervention or an alternative sham intervention that has similar expectancy effects is desirable, particularly if the goal is to determine the effectiveness of a behavioural intervention. The final important assumption—the *heterogeneity assumption*—is that each participant has a sufficiently unique response to treatment to warrant his or her own test of the usefulness of a specific intervention. Estimates of variance in the intervention effect of a large RCT with sufficient heterogeneity of sample characteristics are a good indicator of whether this assumption is likely to be met. If this assumption is not met, then designing and implementing an N-of-1 trial could be inefficient.

As described above, many assumptions and requirements must be met for an N-of-1 trial approach to be appropriate. In this section, we argue that some health habits and habit formation interventions are well-suited treatment targets and interventions for this design. To be appropriate for N-of-1 trials, health behaviours must be measurable across time, so that they can be measured repeatedly, and they must have some potential for variation. For most habitual health behaviours (e.g., dieting, walking, engaging in appropriate sleep behaviour, taking medication as prescribed, and decreasing tobacco consumption), these preconditions are met. For other positive health behaviours (e.g., smoking cessation), however, these conditions are not met. In the case of smoking cessation, unless the person who quits smoking has frequent relapses, we can no longer compare the effect of two or more treatments on smoking cessation across time. Furthermore, we cannot be confident that smoking cessation during the time period of one intervention and not the other was due to the superiority of one intervention over the other. However, if the outcome of interest was number of cigarettes smoked per day, then an N-of-1 trial could be applied.

The second precondition for N-of-1 trials relevant to habit is that the behaviour change intervention to be tested must be able to be withdrawn, and the effects of the intervention must be reversible upon withdrawal. This can be problematic with habit interventions. Once a participant develops a habit, it may be difficult to reverse the effect of the habit formation techniques. Indeed, most of the RCTs underlying the formation of health habits are designed to have long-lasting effects (Lally et al., 2010). However, N-of-1 trials might be ideally suited to comparing different approaches to optimizing the effectiveness of habit formation interventions. For example, one might employ an N-of-1 trial to compare different cues to foster healthy habits. One example would be an N-of-1 trial in which a participant who takes medication only intermittently compares two different cues to take their medication and tracks medication adherence over the course of the trial with an electronic monitor.

A third precondition is having some understanding of the onset and washout periods required between exposures to the habit formation technique. This information is required to set the time for each crossover period. In contrast with designing N-of-1 trials comparing medications, this information is less likely to be known for N-of-1 trials of behavioural interventions. One could learn the range of washout effects and then design the N-of-1 trial with sufficient time between crossovers to make it likely for washout to have occurred in most individuals. With enough treatment repetitions within one participant, we can also conduct statistical analyses that model for time effects of changes in habits that occur during washout periods and build this into the models comparing treatment-specific effects.

Using N-of-1 trials we may compare two or more habit formation techniques with one another, and we may also compare one habit formation technique with "no intervention." It may be challenging to design sham behaviour change techniques or even attention control interventions for N-of-1 trials. Yet, in many cases, having a credible placebo treatment or control condition may be desirable to isolate the benefit of a habit formation intervention. In a similar way, as it may be challenging to determine the onset and washout periods for habit formation techniques, it will likely require a series of N-of-1 trials of habit formation techniques to determine whether the heterogeneity assumption underlying the need for N-of-1 trials applies to that specific behaviour change technique.

In contrast with the universality assumption used for conventional RCTs, the N-of-1 trial approach assumes that each person is sufficiently unique to warrant his or her own test of the usefulness of a specific mechanism of behaviour change.

However, one cannot determine if the heterogeneity or universal assumption is more likely to be operating with a specific habit formation technique unless multiple N-of-1 RCTs are conducted and then pooled together to determine if the mechanism is operating in the same way for the vast majority of study participants. Thus, the N-of-1 design can be applied in many ways (i.e., using observational or experimental N-of-1 trials) that allow a more accurate translation, a better test, and a higher probability of increasing fundamental understanding of many of our habit theories than could ever be possible in a conventional RCT.

In the past, operational complexities made it difficult to conduct N-of-1 studies (Kravitz et al., 2008). A recent systematic review found only 39 articles using N-of-1 methods to study or change health behaviours (McDonald et al., 2017). The authors note that designing an N-of-1 protocol requires investigators to make trade-offs between feasibility, measurement characteristics, scientific rigor and the specificity of the N-of-1 design. Additionally, current methods for statistical analysis of N-of-1 trial data often are not capable of dealing with challenges inherent to this modelling, such as describing adaptive changes over time or investigating carryover effects. Further, although a majority of N-of-1 trials resulted in participants making treatment decisions consistent with the results of the trial, participants also reported feeling burdened by the need to complete multiple assessments for prolonged periods of time, and there were challenges for the N-of-1 trial study teams for obtaining the monitored data in an efficient fashion (Kravitz et al., 2008). N-of-1 design presents challenges; however, many can be mitigated using novel technology.

Operationalizing N-of-1 Approaches to Testing of Habit Theories Using Novel Technology

To develop the next translational steps for properly testing habit formation theory and its related mechanism of action and behaviour change techniques via N-of-1 methods, we require a valid, reliable, and feasible way to assess these mechanisms over time in the real world. In the conceptualization of habit formation theory, the behaviour change technique is the pairing of behaviour with a consistent cue in the given context. Although the “consistent context” or “cue” may seem to be self-evident, more basic foundational research may be needed to understand how to operationalize and then accurately assess these. There are several possible operationalization definitions: location, time, other people, and typical daily activity associated with behaviour (e.g., eating breakfast, commuting, or walking to a cafe). Due to recent technology developments, modern devices and systems exist for collecting data continuously and unobtrusively about these daily dimensions: location (through GPS), time (through a date stamp on the GPS devices), presence of others (via Bluetooth recognition), and typical activities (through ecological momentary assessments, e.g., using a program and a device of choice, such as a mobile phone, laptop, or handheld computer). For example, following the methodology of N-of-1 observational studies, we can unobtrusively and continuously monitor certain daily activities, using smartphone applications to calculate (through a set of algorithms) the likelihood that one is located inside a travelling vehicle.

Testing whether automaticity is attained through behavioural repetition in a consistent context has been limited in the past because of measurement issues. Previous measurement often relied on self-reported or perceived automaticity reported using a questionnaire (e.g., Gardner, Abraham, Lally, & de Bruijn, 2012), thus adding confounds by possible recall bias. An alternative way to capture the construct accurately in the real world may be to assess the cognitive capacities available for other activities during performance of the new behaviour. Thus, when designing habit N-of-1 studies, we need to determine how to assess the mechanism of action as unobtrusively and efficiently as possible. For example, we might decide that the best way to operationalize the hypothesized increase in attention available for other activities that should accompany automaticity may be to use a computerized version of the Stroop test (Stroop, 1935),[2] such as Lumosity (Lumos Labs), a mobile version of this task that requires 45 s to complete. In this hypothetical foundational study, we could randomize participants to the automaticity evaluation condition (which will yield a distribution of automaticity development slopes) or a condition that controls for practice effects, in which the Stroop test is yoked or paired in time with repetitions, but no new behaviour is enacted. This design might allow us to understand if automaticity is occurring and if acute available cognitive capacity is increasing as a result of a lessened need to consciously attend to the new behaviour, and at what dose. In the case of automaticity, Lally et al., 2010 found that the average time for 82 participants to reach the asymptote of automaticity was 66 days (for either eating, drinking, or engaging in an activity), with a range of 18–254 days, when the person was exposed to the consistent situational context and enacted the desired behaviour. This large heterogeneity suggests that automaticity might be better explored in N-of-1 designs that can assess habit development separately for each person and for each behaviour.

Summary

In this chapter, we contrasted within-person N-of-1 methods with traditional between-person approaches. We described observational studies and randomized N-of-1 trials in the context of habit research and provided four illustrative case studies exploring how habit formation differs within and between individuals. We also highlighted the importance of conducting behavioural observational N-of-1 studies before developing interventions to explore patterns of habitual behaviour. N-of-1 RCT allows testing different conditions of the intervention within a person;

[2] In the Stroop test, participants are shown words on their smartphone that appear in a colour of ink that is different from the word it names, and they are then instructed to name the colour in which the word appears rather than the colour named by the word.

this design is not always suitable for habit interventions as many have intended long lasting effects; however, cue and context of the intervention can be randomized and intervention effects explored. N-of-1 designs have a potential to increase the precision of interventions for habit formation allowing us to explore within person behavioural patterns and applying most suitable interventions to each study participant.

Recent methodological, technological, and statistical advances now enable us to examine novel health behaviour theories at the single-participant level. For instance, state-of-the-art mobile health technologies such as mobile phone applications, smart watches, and electronic pillboxes now enable us to couple automated behavioural hovering or monitoring with some of the emerging data analysis frameworks such as thinking of the participant as a complex system. We can now offer new, exciting, and potentially cost-effective ways of engaging individual participants in important health behaviour changes. Thus, we believe that now is an ideal time to pursue N-of-1 methodologies both to achieve fundamental discoveries relevant to habit formation and other behavioural theories as well as to improve the precision of the interventions to improve health habits.

Habit Research in Action

Habit theories posit within-person hypotheses about health changes. However, the classic research method for testing these theories has been to conduct a between-person RCT to test a single behaviour change mechanism. This classic between-person or between-person paradigm assumes that *participants are interchangeable*, that is, that the putative behaviour change technique and mechanism operates the same way for most (if not all) individuals, and that by comparing (with randomization) one group's response to a technique to another group's response to a control condition, we can know how the "average" individual will respond.

This methodology further presupposes that any variance due to individual difference is error variance. This *universality assumption*—that the way a behavioural technique works in the classic RCT will be the same in most other situations, contexts, and people—is the cornerstone upon which the RCT methodology is founded. However, this universality assumption is not true for multifactorial, complex, dynamic processes such as developing health habits. This simplifying assumption of RCTs actually impedes, rather than facilitates, testing useful behavioural change techniques.

To fully understand how people develop healthy habits and break unhealthy ones, we could approach behaviour change theory, technology, statistics, and interventions from a personalized, within-person perspective. Until recently, our ability to assess personalized health behaviours has been limited by unreliable technology, poor measurement, and dated statistical models. New research approaches and innovative and integrative designs, such as N-of-1 methods, are needed to elucidate how theoretical postulates for health behaviour, such as automaticity, operate in individual participants.

References

Berkman, L. F., Blumenthal, J., Burg, M., Carney, R. M., Catellier, D., Cowan, M. J., et al. (2003). Effects of treating depression and low perceived social support on clinical events after myocardial infarction: The Enhancing Recovery in Coronary Heart Disease Patients (ENRICHD) Randomized Trial. *Journal of the American Medical Association, 289*(23), 3106–3116.

Burg, M. M., Schwartz, J. E., Kronish, I. M., Diaz, K. M., Alcantara, C., Duer-Hefele, J., et al. (2017). Does stress result in you exercising less? Or does exercising result in you being less stressed? Or is it both? Testing the bi-directional stress-exercise association at the group and person (N of 1) level. *Annals of Behavioral Medicine, 51*(6), 799–809.

Davidson, K. W., & Cheung, Y. K. (2017). Envisioning a future for precision health psychology: Innovative applied statistical approaches to N-of-1 studies. *Health Psychology Review, 11*(3), 292–294.

Duan, N., Kravitz, R. L., & Schmid, C. H. (2013). Single-patient (n-of-1) trials: A pragmatic clinical decision methodology for patient-centered comparative effectiveness research. *Journal of Clinical Epidemiology, 66*(Suppl. 8), S21–S28. https://doi.org/10.1016/j.jclinepi.2013.04.006

Fernandez, Y. G. E., Nguyen, H., Duan, N., Gabler, N. B., & Kravitz, R. L. (2010). Assessing heterogeneity of treatment effects: Are authors misinterpreting their results? *Health Services Research, 45*(1), 283–301. https://doi.org/10.1111/j.1475-6773.2009.01064.x

Frasure-Smith, N., Lespérance, F., Gravel, G., Masson, A., Juneau, M., & Bourassa, M. (2002). Long-term survival differences among low-anxious, high-anxious and repressive copers enrolled in the Montreal heart attack readjustment trial. *Psychosomatic Medicine, 64*, 571–579.

Gardner, B., Abraham, C., Lally, P., & de Bruijn, G.-J. (2012). Towards parsimony in habit measurement: Testing the convergent and predictive validity of an automaticity subscale of the Self-Report Habit Index. *International Journal of Behavioral Nutrition and Physical Activity, 9*(1), 102.

Guyatt, G., Sackett, D., Taylor, D., Chong, J., Roberts, R., & Pugsley, S. (1986). Determining optimal therapy—Randomized trials in individual patients. *New England Journal of Medicine, 314*, 889–892.

Hall, S. M., Tuskell, C. D., Vila, K. L., & Duffy, J. (1992). Weight gain prevention and smoking cessation: Cautionary findings. *American Journal of Public Health, 82*, 799–803.

Jakicic, J. M., Davis, K. K., Rogers, R. J., King, W. C., Marcus, M. D., Helsel, D., et al. (2016). Effect of wearable technology combined with a lifestyle intervention on long-term weight loss: The IDEA randomized clinical trial. *JAMA, 316*(11), 1161–1171. https://doi.org/10.1001/jama.2016.12858

Johnston, D. W., & Johnston, M. (2013). Useful theories should apply to individuals. *British Journal of Health Psychology, 18*(3), 469–473.

Kravitz, R. L., Duan, N., Niedzinski, E. J., Hay, M. C., Subramanian, S. K., & Weisner, T. S. (2008). What ever happened to N-of-1 trials? Insiders' perspectives and a look to the future. *The Milbank Quarterly, 86*(4), 533–555. https://doi.org/10.1111/j.1468-0009.2008.00533.x

Kwasnicka, D., Dombrowski, S. U., White, M., & Sniehotta, F. F. (2017). N-of-1 study of weight loss maintenance assessing predictors of physical activity, adherence to weight loss plan and weight change. *Psychology & Health, 32*(6), 686–708.

Lally, P., Van Jaarsveld, C. H., Potts, H. W., & Wardle, J. (2010). How are habits formed: Modelling habit formation in the real world. *European Journal of Social Psychology, 40*(6), 998–1009.

Lamiell, J. T. (1998). 'Nomothetic' and 'Idiographic': Contrasting Windelband's understanding with contemporary usage. *Theory & Psychology, 8*(1), 23–38.

McDonald, S., Quinn, F., Vieira, R., O'Brien, N., White, M., Johnston, D. W., et al. (2017). The state of the art and future opportunities for using longitudinal n-of-1 methods in health behaviour research: A systematic literature overview. *Health Psychology Review, 11*(4), 307–323. https://doi.org/10.1080/17437199.2017.1316672

Michie, S., & Johnston, M. (2012). Theories and techniques of behaviour change: Developing a cumulative science of behaviour change. *Health Psychology Review, 6*(1), 1–6. https://doi.org/10.1080/17437199.2012.654964

Mokdad, A. H., Marks, J. S., Stroup, D. F., & Gerberding, J. L. (2004). Actual causes of death in the United States, 2000. *JAMA, 291*(10), 1238–1245. https://doi.org/10.1001/jama.291.10.1238

Murad, M., Asi, N., Alsawas, M., & Alahdab, F. (2016). New evidence pyramid. *Evidence Based Medicine, 21*(4), 125.

Norman, G. J. (2008). Answering the "what works?" question in health behavior change. *American Journal of Preventive Medicine, 34*(5), 449–450.

Nyman, S. R., Goodwin, K., Kwasnicka, D., & Callaway, A. (2016). Increasing walking among older people: A test of behaviour change techniques using factorial randomised N-of-1 trials. *Psychology & Health, 31*(3), 313–330.

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*(1), 54–74. https://doi.org/10.1037/0033-2909.124.1.54

Sackett, D. L., Sharon, E. S., & Richardson, W. S. (2000). *Evidence-based medicine: How to practice and teach EBM* (2nd ed.). London: Churchill Livingstone.

Shiffman, S., Stone, A. A., & Hufford, M. R. (2008). Ecological momentary assessment. *Annual Review of Clinical Psychology, 4*, 1–32.

Spring, B., Ockene, J. K., Gidding, S. S., Mozaffarian, D., Moore, S., Rosal, M. C., et al. (2013). Better population health through behavior change in adults: A call to action. *Circulation, 128*(19), 2169–2176. https://doi.org/10.1161/01.cir.0000435173.25936.e1

Stroop, J. R. (1935). Studies of interference in serial verbal reactions. *Journal of Experimental Psychology, 18*, 643–662.

Verplanken, B., & Orbell, S. (2003). Reflections on past behavior: A self-report index of habit strength. *Journal of Applied Social Psychology, 33*(6), 1313–1330.

Chapter 14
Creating and Breaking Habit in Healthcare Professional Behaviours to Improve Healthcare and Health

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The Role of Habit in Predicting the Behaviour of Healthcare Professionals

Habit can be defined as a phenomenon whereby internal and external cues trigger automatic reactions, based on a learned stimulus–response association (Gardner, 2014). Repeated performance in a stable context is a defining characteristic of habit (Lally, van Jaarsveld, Potts, & Wardle, 2010). As applied to health care professionals (HCP) behaviour, consider a disinfectant dispenser at an elevator that may cue HCPs to automatically disinfect their hands. Initially, the decision to disinfect their hands may be a deliberate process; however, sufficient cueing and repetition may

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automatically trigger hand sanitising behaviour. Hand sanitising is but one of the many routine clinical actions for HCPs. Some actions, like hand sanitising, serve a health-protective purpose, while others affect patients more directly in the provision of healthcare, including the range of examination, testing, prescribing, advising, surgical, and referral behaviours.

New medications, interventions, and technologies continue to be developed with the potential to improve patient and public health. The availability of these new developments does not guarantee that patients will receive them. A considerable amount of healthcare provided to patients is either not needed, outdated, or potentially harmful (Prasad & Ioannidis, 2014). Recognizing that provision of evidence-informed care to patients requires HCPs to change their own clinical behaviour, a concerted effort within the field of Implementation Science draws upon behavioural science to support HCP behaviour change. The nature of such behaviours, prototypically characterised by a social and physical setting that promotes repetition of behaviour, favours the formation of habitual clinical behaviours that rely less solely on a process of active reflection and involve more automatic responses to cues (see Table 14.1). Given competing demands, time, and resource constraints faced by HCPs (Presseau, Francis, Campbell, & Sniehotta, 2011; Presseau, Sniehotta, Francis, & Campbell, 2009), habit formation may be adaptive, minimizing cognitive resources required for a given behaviour to ensure that it can be performed with a maximum of patients and/or for when such resources are especially needed.

Table 14.1 Characteristics of healthcare professional behaviour that may promote habit formation and undermine habit reversal

Characteristics of environment/context in which healthcare professionals work	Mechanisms of habit formation
Training (Reyna, 2008)	During clinical training HCPs repeat the same behaviours in a stable context, which facilitates cue-response associations
Performance environment replete with physical cues that create contingencies (Shojania et al., 2010)	HCPs are constantly exposed to physical (e.g., clinical instruments) cues that trigger behaviour repeatedly
Clear performance rules (policies) and professional roles (Schoenwald, 2010)	Policies and roles facilitate the safe performance of clinical behaviours, which facilitate habit formation. When policies and roles change there is a need for habit change
Healthcare is provided within multidisciplinary teams of junior and more experienced HCPs (Hofmann et al., 2008)	HCPs often act in response to being prompted by colleagues in their team. Such social cueing can maintain behaviour and lead to habit formation
Clinical actions can be influenced by patient and caregiver expectations and behaviours (De Sutter, De Meyere, De Maeseneer, & Peersman, 2001)	Patient and caregivers often have expectations for the care they think they should receive. Sometimes patients may express their expectations to the HCPs, which may prompt habitual behaviour
Time pressure (Johnston et al., 2015)	With little time on their hands HCPs are often required to act fast and efficiently in the face of multiple demands
Remuneration (reinforcement) schedules (Flodgren et al., 2011)	Some healthcare systems link specific remuneration for very specific behaviours, encouraging repetition and habit formation

Habit can manifest itself in two ways: by triggering the initiation of behaviour (habitual instigation), and/or by promoting the subsequent course of action (habitual execution) (Gardner, Phillips, & Judah, 2016). HCPs may be habitually triggered to sanitise their hands upon encountering the sanitising gel dispenser after patient contact without requiring conscious deliberation (habitual instigation), and may then find themselves applying the gel and rubbing their hands without giving it much attention or active reflection (habitual execution). Depending on the clinical behaviour and circumstances, both habitual instigation and habitual execution of skilled clinical behaviours save cognitive resources for the behaviours and circumstances requiring activation of reflective processes. However, habitual behaviours can become maladaptive when they maintain clinical actions that should be replaced by better evidenced practices (e.g. a new type of medication), clinical actions for which there is no evidence of patient benefit (e.g. using a plaster cast on children with small fractures on one side of the wrist; treatment with a removable splint and written information suffices; Handoll, Elliott, Iheozor-Ejiofor, Hunter, & Karantana, 2016), or clinical actions for which evidence suggests it may cause more harm than benefit (e.g. antibiotic prescribing for upper respiratory tract infection; Kenealy & Arroll, 2013).

Habit influences HCPs' behaviour. A systematic review and meta-analysis of nine studies including 1975 HCPs found a medium-sized combined effect for the association between habit and HCP behaviour (Potthoff, Rasul, et al., under review). This effect size is similar in magnitude to the association between intention and behaviour (Godin, Belanger-Gravel, Eccles, & Grimshaw, 2008), covering a range of HCP behaviours. While there is clear evidence for the role of habit in HCP behaviour, there is a need for more research that includes measures of habit in this literature (Potthoff, Rasul, et al., under review).

A better understanding of how and under what conditions habit influences HCP behaviour could help to design more effective interventions to support HCP behaviour change and better healthcare. Such an understanding can draw on theories of behaviour that describe how impulsive and deliberate processes interact to influence behaviour. There is a growing evidence-base supporting the utility of such theories for understanding and changing HCP behaviour (Fuller et al., 2012; Potthoff, Presseau, Sniehotta, Elovainio, & Avery, 2017; Presseau et al., 2014). In the following section we describe a selection of such contemporary theories applied to better understand habit in relation to HCP behaviour and highlight opportunities for further theory development to drive forward our understanding of habit.

Theoretical Approaches to Understanding Habit in Healthcare Professionals

Contemporary theories of behaviour portray human behaviour as the result of conscious and unconscious processes (Evans, 2008). Three theories that have been used to date to understand and predict HCP behaviour include the Reflective Impulsive Model (RIM; Strack & Deutsch, 2014), Fuzzy Trace Theory (FTT; Reyna & Brainerd, 2011) and Novice to Expert Theory (NET; Benner, 1982). Although these theories use different terminology, there are key similarities between them

(Stanovich & West, 2000), and collectively they have commonly been called dual process theories composed of two systems (Evans, 2008). One system (1) is characterised as fast, effortless, unconscious, and automatic; the other (2), as slow, effortful, conscious, and deliberate (Stanovich & West, 2000). In this chapter we use Strack and Deutsch's terms '*reflective*' and '*impulsive*' to describe the two systems (Strack & Deutsch, 2004; Strack, Werth', & Deutsch, 2006). Habit is one of the processes of the impulsive system, however there are other processes that are part of this system (e.g. goal-directed automaticity; Wood & Neal, 2007). In the discussion below we focus on habitual automatic processes, rather than other non-habitual automatic processes.

Reflective Impulsive Model (RIM)

The RIM offers a comprehensive account of these two systems and describes their most important properties and functions (Strack et al., 2006; Strack & Deutsch, 2004). In contrast to some other dual processing theories (e.g. Heuristic-Analytical Theory; Evans, 1989) the RIM postulates that the reflective and impulsive system function in parallel, such that the impulsive system is always active whereas the reflective system may be disengaged (Strack et al., 2006). Applied to HCP behaviour, an experienced nurse may for instance draw blood from a patients' arm without engagement of the reflective system. However, there may be patients whose veins are less visible, requiring the reflective system to be engaged to assist the impulsive system in the operation of behaviour.

The two systems differ in their processing *capacity*. The reflective system has limited capacity and does not deal well with distractions or extreme levels of arousal. The impulsive system on the other hand operates even under suboptimal conditions (Strack et al., 2006). HCPs are often under considerable pressure, work long hours (often in shifts). As they navigate multiple demands they rely on well-rehearsed routines that allow them to provide optimal care.

The reflective and impulsive systems also differ in how they process information. When HCPs acquire new knowledge during training and clinical practice they draw heavily on the reflective system to form new semantic connections in memory (Strack et al., 2006; Strack & Deutsch, 2014). A HCP in training may learn that hand hygiene is important to prevent the spread of infection. The impulsive system relies on associative links formed through repeated experience in similar settings (e.g. hand gel dispenser near elevator becomes a cue for hand sanitizing after sufficient repetition).

An extension of the RIM describes a range of situational and dispositional *boundary conditions* (see Table 14.2) that influence whether the impulsive or reflective system is dominant in controlling behaviour (Hofmann, Friese, & Wiers, 2008). Low cognitive control resources (e.g. due to tiredness or stress) may lower the functioning of the reflective system whilst favouring action driven by the impulsive system. For example, in the case of treating a sore throat, clinical practice guidelines

Table 14.2 Potential boundary conditions that may promote the impulsive system in healthcare professionals

Boundary condition	Boundary condition as applied to healthcare professional context
Stress	A variety of factors can contribute to high stress levels in HCPs. This may include long working hours, lack of staff, patients with difficult problems, and medical emergencies
Fatigue	Working hours of HCPs often stretch until late in the night and overtime can be the norm rather than the exception
Cognitive load	HCPs have to perform highly complex tasks involving reading and interpreting test results, diagnosing, prescribing, and advising. These tasks have the potential to draw heavily on cognitive resources
Emotional exhaustion	Many of the behaviours that HCPs perform have severe consequences for patient health. There are also things that happen to the patient that are sometimes outside of HCPs' control (e.g., death or other family tragedies)
Physical exhaustion	Some tasks that HCPs such as nurses perform can put severe strain on the body (e.g., moving patients in and from the bed)
Experience	With increased experience the amount of behavioural repetitions of clinical actions increases, which facilitates habit formation
Hunger	Research shows that hunger is associated with more impulsive processing. With high amounts of pressure HCPs may sometimes not find the time to have a meal or a snack which may cause them to act more habitually
Time pressure	HCPs often work under time pressure requiring them to act fast in response to the problems they are encountering. Such time constraints may favour impulsive actions
Presence of old cues	There may be cues in the HCP's context which prompt habitual behaviours that are no longer in line with best practice (e.g. if a HCP is no longer recommended to order a specific diagnostic test, but the test ordering form is not updated and so the test still appears at the top of the form). In such situations impulsive actions may be favoured over more reflective processing

encourage HCPs to advise patients that sore throat can last around 1 week and that they should manage their symptoms with self-care rather than medication. However, a more habitual (not guideline recommended) response may be to prescribe an antibiotic. In such a scenario a conflict in behavioural schemas (i.e. repetitive actions that are represented as generalisations in memory) may arise. If control resources are high (e.g. no time pressure, motivated patient) HCPs may advise to manage symptoms with self-care (reflective system response). However, if there is a lack of time the reflective system might fail to inhibit the impulsive system prompting the HCP to prescribe an antibiotic (impulsive system response). Indeed, Linder et al. (2014) showed that the likelihood of inappropriate antibiotic prescribing for acute respiratory infection increases during the course of both morning and afternoon clinic sessions, consistent with the hypothesis that impulsive responses are more likely when cognitive resources become depleted. Boundary conditions highlight the need for promoting the formation of evidence-based habit that allow HCPs to act appropriately even in high-pressure conditions (Hofmann et al., 2008).

RIM principles have been investigated in predictive studies of HCP behaviour. One study tested the utility of a dual process model to predict six different clinical practice guideline-recommended behaviours performed in type 2 diabetes management in primary care (Presseau et al., 2014). The reflective pathway was predictive of all six behaviours, indicating the importance of deliberate decision-making. Importantly, the study also found that the impulsive system (represented by habit) accounted for significant amount of variability in four of the six clinical behaviours alongside the reflective system, suggesting that automatic processes are an important predictor of HCP behaviour. Other research has used patient scenarios to investigate primary care physicians' simulated antibiotic prescribing for upper respiratory tract infection. The study found that appropriate (no prescribing) decisions were more likely when difficulty with decision-making was lower and decision time was shorter, indicating that appropriate prescribing decisions can be made quickly using a less effortful cognitive process (McCleary et al., 2017). These results consistently show that rapid clinical actions may involve the use of intuitive processes and can be as accurate as clinical actions involving reflective processes, supporting their appropriateness in clinical settings, which may be contrary to popular belief that careful reflection is always favoured.

Fuzzy Trace Theory (FTT)

FTT explains how the reflective and impulsive system interact with human memory (Reyna & Brainerd, 2002). In FTT, memories are represented as *verbatim* and *gist traces.* For most decision-making, people draw on gist traces, which are 'fuzzy' representations of past events (e.g. mental shortcuts). For example, in their daily practice some HCPs prefer judging risks in terms of high or low, rather than trying to recollect precise risk probabilities (Reyna & Brainerd, 2007). Verbatim traces are detailed representations of past events, including recollections such as ratio concepts. In contrast to some other dual process theories, FTT assumes that behaviours that are the result of gist-based decision-making can sometimes be more accurate than behaviours resulting from verbatim-based decision-making (Reyna, 2008). Importantly, reliance on gist traces is only superior if the actor is experienced in the topic of question. In line with this proposition HCPs with a lot of clinical experience are better advised to act according to their intuition rather than relying on verbatim-based reasoning. One study tested the so-called unconscious thought effect*,* which refers to the phenomenon that some people make better decisions after being distracted for a period of time (de Vries, Witteman, Holland, & Dijksterhuis, 2010). The authors studied this effect in relation to one of the most difficult clinical decision-making processes: diagnosis. The study aimed to assess the effects of unconscious thought on the precision of diagnosis of psychiatric cases. Half of the participating HCPs were asked to consciously reflect on a clinical case before making their diagnosis. The other half of HCPs had to perform an unrelated distracter task. Compared to the conscious processing condition, HCPs in the 'unconscious' condition (distracter task) achieved a higher number of correct classifications (de Vries et al., 2010). The study highlights the potential importance of unconscious decision-making in trained HCPs; it also has important implications for habit formation and reversal in trained healthcare professionals.

Novice to Expert Theory (NET)

The Novice to Expert Theory (NET; Benner, 1982) was developed in the field of nursing and builds on Dreyfus Model of Skill Acquisition (Dreyfus, 1992). According to this model people pass through five levels of proficiency as they acquire new skills: novice, advanced beginner, competent, proficient, and expert. NET posits that nurses in the early stages of skill acquisition (i.e. novice and advanced beginner stage) rely mostly on reflective processing as they apply rules learned during their clinical training. For example, to determine fluid balance in a patient, nurses may check morning weights and daily intake of outputs during the past days. During this forming period nurses rely on mentoring as they have not yet learned how to see the wider context and prioritise their actions. As nurses gain more experience and move through the stages of competence to expert they become less reliant on rules and their behaviour is more guided by intuition (in line with the impulsive system). When experts are asked why they performed certain masterful actions they will often reply, 'Because it felt right. It looked good' (Benner, 1982). NET posits that with increased experience behaviour moves more into the background of experience rather than being controlled by conscious processes. However, the theory does not say that expert behaviour is never driven by reflective processes. According to NET, experts still make use of analytical thinking when they are confronted with novel or difficult situations. The NET draws attention to potentially tailoring HCP behaviour change interventions to the phase of skill acquisition. For example, in the early stages of skill acquisition (habit formation) HCPs may benefit from role-playing and practicing behaviours in an applied or simulated setting. Advanced beginners also benefit from mentors who help them prioritise certain tasks. Proficient HCPs like case examples to advance their knowledge and skills. Lastly, experts may need to watch video observations of their own behaviours to become aware and be able to change their habits (Benner, 1982).

What Does Each of the Theories Uniquely Contribute?

When choosing a theory to help understand HCP behaviour or to design and evaluate an intervention to change HCP behaviour it is important to understand what each theory uniquely contributes (Birken et al., 2017). The RIM describes the circumstances under which each system (i.e. reflective and impulsive) is dominant in controlling behaviour. The model specifies *boundary conditions* that influence whether people's behaviour is likely to be the result of reflection or impulse. The unique contribution of FTT is that it describes how HCP use heuristics to guide behaviour. Importantly, the theory describes how, with increased experience, HCPs rely more heavily on such short cuts, allowing them to solve complex tasks efficiently. However, in some situations heuristics can also lead to bias, causing inappropriate actions. The NET describes how HCPs acquire new skills and how these skills become habitual over time. According to this theory behaviour is more strongly lead by the impulsive system as HCPs gain experience in their profession. It assumes that during the initial years of their career and when developing new skills, HCP behaviour is mostly driven by reflection; however, that the experience of behaviour moves more into the background of consciousness as experience increases. It provides clear guidance for training that may support HCPs at different stages of expertise in improving their skills.

Measuring Habit in Healthcare Professionals

Studies to date examining the role of habit in relation to HCP behaviour have used self-reported measures (Potthoff, Rasul, et al., under review), with most studies using a 2–3 item 'Evidence of Habit' measure (Eccles et al., 2011) derived from Learning Theory (Blackman, 1974) which focuses on the automaticity facet of habit (e.g. 'When I see a patient I automatically consider taking a radiograph'). For example, a cross-sectional study found a significant relationship between measures of habit and physicians' self-reported referral for lumbar spine x-rays (Grimshaw et al., 2011). Two other self-reported measures are the Self-Report Habit Index (SRHI; Verplanken & Orbell, 2003) and the shorter Self-Report Behavioural Automaticity Index derived from four items within the SRHI that focus on automaticity (Gardner, Abraham, Lally, & Bruijn, 2012). A prospective study using the SRBAI showed that automaticity accounted for significant amounts of variability in HCPs' behaviour over and above reflective constructs (Presseau et al., 2014). Given that much of the research on HCPs takes place in an applied setting it is not surprising that measurement of habit in this context has been restricted to self-report. Though self-report measures are a feasible method of measuring habit in HCPs they clearly have limitations (see Chap. 3 for an in-depth discussion).

To advance the measurement of habit in HCPs, future studies could make use of routinely collected health administrative data gathered within healthcare systems to study habit and the impact of reflective and impulsive cognitive processes on HCP behaviour, in particular to investigate boundary conditions that may determine whether reflective or impulsive processes are engaged. As described above, Linder et al. (2014) used billing and electronic health record data to indicate that inappropriate antibiotic prescribing for acute respiratory infection was more likely to occur near the end of clinic sessions, when cognitive resources are likely depleted. Further work is needed to investigate this across a range of clinical behaviours, which may form the basis of suggestions for interventions aiming to change environments in order to change behaviour (for example, Linder and colleagues suggest time-dependent decision support, shorter clinic sessions, mandatory breaks, or snacks). Also there is a need to triangulate findings by using a range of measures (e.g. self-reported habit measures alongside routine data) to validate any results.

To overcome difficulties of recalling habit cues (Gardner & Tang, 2013) future studies could employ self-reported habit measures in combination with video observations of HCPs' clinical behaviours. Seeing their behaviour in action may enable HCPs to make a more informed assessment about the level of automaticity of a given behaviour. Video observations can be further combined with conversation analysis which is a method to assess cues and automatic behaviours by examining interactions and the verbal and non-verbal cues that drive HCPs behaviour (Drew, Chatwin, & Collins, 2001). Overall, self-report measures are the most commonly applied method of measuring habit in HCPs but have clear limitations. Using self-report measures in combination with other methods may help overcome some of these limitations.

Strategies for Creating and Breaking Habit in Healthcare Professionals

Behaviour change strategies can be used to support HCPs with changing their behaviour by addressing habitual processes. This may involve creating new routines for delivering evidence-based care, substituting old ways of providing care with new practices, or breaking routines leading to outdated and potentially harmful care.

Creating Habit in Healthcare Professionals

Healthcare professional behaviour change interventions predominantly target reflective processes by providing HCPs with information (Giguère et al., 2012), revising professional roles (Glisson et al., 2010), or using mass media to inform a large number of HCPs of a new innovation (Magnabosco, 2006). Different types of interventions, or intervention components, are likely needed to influence impulsive processes. Habit formation requires two main ingredients: behavioural repetition and the presence of consistent contextual cues (Lally & Gardner, 2013). Once a habit has been established, electronic reminders have the potential to serve as cues to trigger initiation and their effectiveness to change HCPs' behaviour has been shown in systematic reviews (Shojania et al., 2010). Reminders may be installed on HCPs practice computers to prompt the enactment of a particular practice during a clinical encounter. HCPs in a qualitative study reported that electronic pop-up reminders in their patients' electronic records supported them with making more frequent use of an information prescription for type 2 diabetes (Potthoff, Presseau, et al., under review). Importantly, they reported that it was essential that pop-up reminders only appeared for patients for whom an information prescription was appropriate. Therefore it is important that electronic reminder systems incorporate intelligent algorithms with key cue-behaviour contingencies that prevent too frequent reminding of HCPs (Potthoff, Presseau, et al., under review). Notably, the issue of 'alert fatigue' (too many alerts) may lead to ignoring or override them (Ash, Sittig, Campbell, Guappone, & Dykstra, 2007). It is therefore important to balance the use of electronic pop-up reminders with other strategies aiming to influence habit.

Other strategies can be leveraged to use the reflective process to 'program' the impulsive process, such as implementation intentions and action and coping planning (Gollwitzer, 1999; Hagger et al., 2016; Sniehotta, 2009). Action plans are very specific plans of when, where and how to perform a specific behaviour (Sniehotta, 2009). For example, an action plan for hand washing could be 'When I remove my protective gloves after surgery, then I will wash my hands at the sink outside the operating theatre' (see also Chap. 10 in this volume). Coping plans are specific plans to overcome pre-identified barriers to an intended behaviour (Kwasnicka, Presseau, White, & Sniehotta, 2013). For example, a coping plan could be 'If the soap dispenser outside the operating theatre is empty, then I will ask someone to refill it'. There is evidence suggesting that such planning interventions are effective in supporting HCP behaviour change (Casper, 2008; Squires et al., 2013; Verbiest et al., 2014). For example, one study found that 80% of HCPs who formed an implementation intention for when, where and how to use staff-guided procedures in addition to receiving clinical training changed their behaviour, compared to 58% of HCPs who received the training alone (Casper, 2008). Furthermore, a study assessing the mechanisms through which planning may effect HCP behaviour showed that the relationship between action and coping planning and six clinical behaviours was mediated by habit (Potthoff et al., 2017). Together, these results suggest that HCPs who formulated a specific plan may have formed a cognitive link between an opportunity to act and an appropriate response (i.e. providing guideline recommended care), allowing them to act in a fast and intuitive way, rather than having to rely on effortful decision-making each time (Potthoff et al., 2017).

Breaking Habit in Healthcare Professionals

HCP behaviours also offer an opportunity to test strategies that could be effective in *breaking* existing habit. For example, the 'Choosing Wisely' initiative provides lists of unnecessary tests, treatments, and procedures (www.choosingwisely.org).

One of the items on the list recommends not imaging for low back pain within the first 6 weeks, unless red flags are present. Initiatives such as Choosing Wisely aim to change HCPs routines through media campaigns that are intended to educate HCPs.

However, just as the provision of information is insufficient for creating habit, it is likely also insufficient as a strategy for helping HCPs to break habit because the clinical context remains full of contextual cues that may prompt the habit, even when it is a *dormant habit*. Dormant habit describes existing habits that are only prompted rarely due to infrequent encounters of relevant cues (Gardner et al., 2012). One way of disrupting the influence of old undesired habit is to remove any contextual cues that may trigger automatic responses (Verplanken & Melkevik, 2008). This could involve removing outdated information leaflets, checklists for test orders, computer prompts, or making access to over-prescribed medications and lab tests more difficult. A systematic review found that interventions such as those involving changes to laboratory forms (e.g. removing checkboxes for overused lab tests from laboratory order form) resulted in significant reductions in test-ordering (Thomas, Vaska, Naugler, & Turin, 2015). A vignette-based study looked at whether grouping of menu items in electronic health records (EHR) would affect primary care physicians' prescribing behaviour of antibiotics (Tannenbaum et al., 2015). The study found reduction in the prescription of antibiotics when over-the-counter (OTC) medications were listed separately followed by all prescription medications, as opposed to the opposite (all prescription medications listed separately followed by all OTC medication options in one group). These results suggest that changes to the configuration of EHR can be used as a way of encouraging guideline-appropriate behaviours.

Removing or changing contextual cues may not always be feasible, especially if the patient themselves provide the social cue for a specific behaviour (e.g. patient with an upper respiratory tract infection (URTI) asking for an antibiotic). In such cases HCPs could formulate implementation intentions that help them respond to an old habit cue in a more desirable way (Adriaanse, Gollwitzer, De Ridder, de Wit, & Kroese, 2011). For example, if patients with an URTI prompt HCPs to overprescribe antibiotics they may want to form a plan that helps them substitute this behaviour with a more desired response (Helfrich et al., 2018). Such a plan could be as follows 'If a patient with URTI asks for an antibiotic, then I will explain that it is important to first monitor the progression of the infection before prescribing an antibiotic'. Studies have indicated that planning may also contribute to breaking existing habitual behaviours: interventions involving action planning can influence primary care physicians' self-efficacy in managing URTI without prescribing antibiotics, and reduce their likelihood of prescribing antibiotics in response to patient scenarios (Hrisos et al., 2008; Treweek et al., 2016).

Intervention strategies aimed at reducing cognitive effort and capitalising on the use of heuristics may contribute to the formation and/or breaking of HCP habit. Fischer et al. (2002) compared two tools for assisting hospital clinicians in identifying *Mycoplasma pneumoniae* as the cause of community-acquired pneumonia in children, and subsequently targeting the prescription of macrolide antibiotics. The first was a scoring system derived from a logistic regression analysis, which required a clinician to look up scores representing the risk of infection. The clinician summed the scores before consulting a risk interpretation sheet. The second tool was a fast-and-frugal decision tree, consisting of two yes/no questions for the clinician relating to the duration of fever and the child's age. Both tools performed similarly well in identifying children at risk (Fischer et al., 2002). However, the fast-and-frugal tree was more straightforward and could be easily memorised. Strategies such as these may assist HCPs in breaking old habits based on outdated evidence, and set the stage for habit formation of behaviours based on updated best available current evidence, in turn contributing to improving the quality of healthcare (see Table 14.3 for additional strategies).

Table 14.3 Potential strategies to address impulsive processing in healthcare professionals

Strategy	Definition/description of strategy
Learning Theory strategies (Skinner, 1963)	These techniques focus on producing change in behaviour by delivering reinforcement (e.g., through remuneration) or punishment (e.g., disciplinary actions or sanctions). When these strategies are applied to HCPs it is important to consider the complexity of the behaviour and the scheduling of reinforcement or punishment
Techniques leveraging social cues	This technique could involve engaging patients to prompt HCPs to provide certain clinical services. For example, media campaigns could be used to encourage patients to ask their HCP to provide them with advise on a given health behaviour. Such patient-mediated approaches are already being used successfully to support the implementation of new medical innovations
Techniques that change the physical environment (Wood & Neal, 2007)	This could involve both adding and removing physical cues in the clinical environment. For example, stickers or posters could be added in practices. Equally, stimuli that relate to undesired practices (e.g., packaging of overprescribed medications or checkboxes for overused lab tests on forms) could be removed
Techniques dealing with emotion and stress (Shapiro, Astin, Bishop, & Cordova, 2005)	Evidence based stress-management interventions may be suitable to reduce unhelpful habitual behaviours
Behavioural substitution (Wood & Neal, 2007)	This technique involves increasing the frequency of a behaviour whilst reducing the frequency of another. For example, HCPs could provide physical activity advice to people with lower back pain instead of prescribing an opioid where appropriate
Implementation intentions (Gollwitzer & Sheeran, 2006)	Prompting HCPs to make specific If-then plans linking situational cues with responses that are in line with delivering best practice care. For example, HCPs could make a plan to provide physical activity advise if a patients' BMI is outside the recommended range

(continued)

Coping planning (Kwasnicka et al., 2013)	Getting HCPs to identify barriers to providing evidence-based care and ways to overcome these. For example, if a patient is eligible to receive physical activity advice but the HCP is running out of time he might provide a leaflet, which provides further information
Public commitment (Ajzen, Czasch, & Flood, 2009)	Stimulating HCPs to commit to engaging themselves to deliver evidence-based care to their patients, and announcing that decision to their co-workers. For example, a healthcare professional could announce to his co-workers that he will from now on deliver self-management advise to all his patients with chronic conditions who have not received this type of advice before
Audit and feedback (Ivers et al., 2012)	Gather and summarise data on the performance of specific clinical behaviours and feeding back to HCPs. This technique can be applied to either increase or decrease the performance of habitual actions

Next Steps

Future research should explicitly test predictions of theories that hypothesise how the impulsive process influences HCP behaviour alongside the reflective process. For example, in Table 14.2 we provided a list of potential boundary conditions that may promote the functioning of the impulsive process. Thus far, there has been relatively little research exploring the effects of boundary conditions on HCP habitual behaviour (Linder et al., 2014). Future research could explore how boundary conditions such as stress, fatigue, or cognitive load affect clinical behaviours, for instance if habitual behaviours (e.g. use of unnecessary diagnostic tests) are performed at a higher rate when HCPs are under stress (e.g. busy clinic). Similarly, research could explore the role of professional experience as a moderator of the habit–behaviour relationship as hypothesised by the Fuzzy Trace Theory. This could be done by looking at whether more experienced HCPs rely more heavily on the impulsive process when delivering healthcare.

Future research should explore novel habit measurement that addresses core facets of the habit construct (e.g. cue-dependency and underlying stimulus–response association). For example, one way of inferring the level of automaticity of a given clinical behaviour could be by testing its dependency on physical cues. If adding or removing a simple cue to a HCPs' environment has a direct effect on behaviour it could be reasoned that behaviour was driven by the impulsive process. An example of this idea is the cues-of-being-watched paradigm in which placing an image of a pair of eyes above an 'honesty box' for hot drinks, can lead to higher amount of contributions (Bateson, Nettle, & Roberts, 2006).

There is a need to further explore effective habit change strategies. One way of doing this could be through theory-based process evaluation alongside experimental or quasi-experimental studies (Presseau et al., 2015). Such an approach could help evaluate the active ingredients of existing implementation strategies such as reminding clinicians, altering incentive/allowance structures, or obtaining formal commitments (Powell et al., 2015). To do this, trials should include measures of

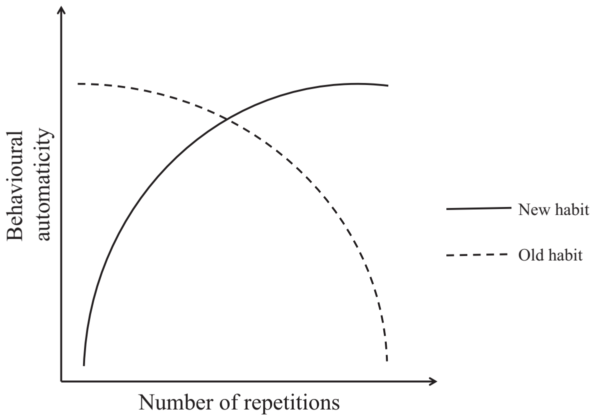

Fig. 14.1 Formation of a new clinical habit and simultaneous breaking of old clinical habit

habit (e.g. self-report) to investigate whether there are any measurable post-intervention changes in automatic processing.

Lastly, more research is needed to uncover whether there are particular clinical behaviours that are more or less conducive to habit formation, or whether the circumstances drive habit formation across clinical behaviours. Evidence from a meta-analytic synthesis shows that behavioural frequency and stability of the context may be two key characteristics, which may help determine which behaviours are more conducive to habit formation (i.e. behaviours that are performed more frequently in a stable context are more likely to become routine) (Ouellette & Wood, 1998). An implication of these findings is that if we want to support HCPs with forming new habits of providing evidence-based care it is important to ensure that the new behaviour is repeated sufficiently in a stable context. Further research is needed to understand how many repetitions are necessary for a given behaviour to become habitual in the presence of specific contextual cues. Equally, the formation of new habit often necessitates breaking old habit and it should not be assumed that a newly formed habit will replace a pre-existing habit, even if the latter is rarely performed. Future research should investigate both the increase in focal habit alongside a decrease in pre-existing habit (see Fig. 14.1).

Conclusion

This chapter provided a state-of-the-art overview of theoretical approaches to understanding habit in HCPs and strategies for creating and breaking habit in HCPs. Given the nature of the setting in which HCPs provide healthcare, habit is a centrally important construct to understand and target when changing clinical practice. Theories and strategies from the behavioural sciences may provide the necessary tools to effectively change HCPs behaviour and improve care provided to patients. Much opportunity remains to advance habit theory and methods by leveraging the unique properties of HCP behaviour and the settings in which they are enacted, which naturally facilitate habit formation.

Habit Research in Action

Understanding habit in relation to planning

The volitional constructs action planning (planning when, where and how to perform a behaviour) and coping planning (planning how to overcome predefined barriers) are theorised to have a positive relationship with behaviour and there is evidence to support this hypothesis in both general population (Sniehotta, 2009) and HCP populations (Casper, 2008). Planning promotes behavioural repetition through the creation of cue–response associations in memory (Gollwitzer, 1999). Given that behavioural repetition and cue–response links are two of the key ingredients in habit formation we hypothesised that habit would mediate the relationship between planning and behaviour (Potthoff et al., 2017). We tested this hypothesis in a study that aimed to explore psychological constructs that could predict the provision of six underperformed prescribing, examining, and advising behaviours in diabetes care (Eccles et al., 2011). General practitioners and practice nurses (n = 427 from 99 UK primary care practices) completed measures of action planning, coping planning, and habit at baseline and then self-reported their enactment of guideline-recommended advising, prescribing, and examining behaviours at 12 months follow-up. To measure habit we used the four-item Self-Report Behavioural Automaticity Index (SRBAI; Gardner et al., 2012). We ran 12 separate bootstrapped mediation analyses using Preacher and Hayes (2008) INDIRECT macro to test our mediation model (see Fig. 14.2). Bootstrapped mediation analysis involves repeatedly resampling from the data and is arguably the most robust method for testing mediation effects (MacKinnon, Lockwood, & Williams, 2004). As predicted we found that action planning and coping planning were positively related to the six behaviours and that these relationships operated indirectly through their relationships with habit.

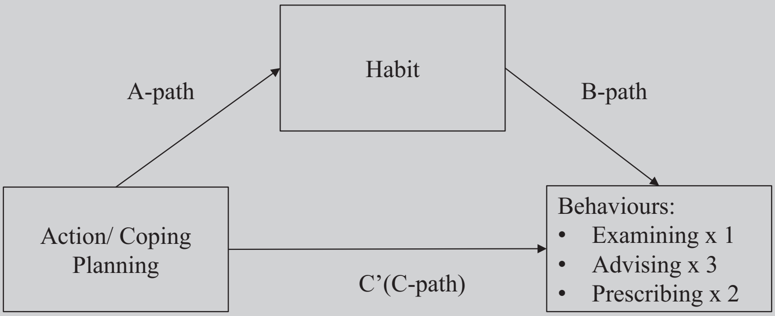

Fig. 14.2 Indirect effects of action and coping planning on healthcare professional behaviours through habit. Path *a* is the direct effect of the predictor variable (action/coping planning) on the mediator (habit). Path *b* is the direct effect of the mediator on the outcome variable (clinical behaviour). Path *c* is the direct effect of the predictor on the outcome variable. Path c' is the indirect effect of the predictor variable on the outcome variable. Adapted from 'Planning to be routine: habit as a mediator of the planning-behaviour relationship in healthcare professionals' by S. Potthoff et al., *Implementation Science, 12*, p. 5. Adapted with permission

References

Adriaanse, M. A., Gollwitzer, P. M., De Ridder, D. T., de Wit, J. B., & Kroese, F. M. (2011). Breaking habits with implementation intentions: A test of underlying processes. *Personality & Social Psychological Bulletin, 37*(4), 502–513. https://doi.org/10.1177/0146167211399102

Ajzen, I., Czasch, C., & Flood, M. G. (2009). From intentions to behavior: Implementation intention, commitment, and conscientiousness. *Journal of Applied Social Psychology, 39*(6), 1356–1372.

Ash, J. S., Sittig, D. F., Campbell, E. M., Guappone, K. P., & Dykstra, R. H. (2007). *Some unintended consequences of clinical decision support systems*. Paper presented at the AMIA Annual Symposium Proceedings.

Bateson, M., Nettle, D., & Roberts, G. (2006). Cues of being watched enhance cooperation in a real-world setting. *Biology Letters, 2*(3), 412–414. https://doi.org/10.1098/rsbl.2006.0509

Benner, P. (1982). From novice to expert. *AJN The American Journal of Nursing, 82*(3), 402–407. https://doi.org/10.2307/3462928

Birken, S. A., Powell, B. J., Shea, C. M., Haines, E. R., Alexis Kirk, M., Leeman, J., et al. (2017). Criteria for selecting implementation science theories and frameworks: Results from an international survey. *Implementation Science, 12*(1), 124. https://doi.org/10.1186/s13012-017-0656-y

Blackman, D. (1974). *Operant conditioning: An experimental analysis of behavior*. London: Methuen.

Casper, E. S. (2008). Using implementation intentions to teach practitioners: Changing practice behaviours via continuing education. *Psychiatric Services, 59*(7), 748–752.

De Sutter, A. I., De Meyere, M. J., De Maeseneer, J. M., & Peersman, W. P. (2001). Antibiotic prescribing in acute infections of the nose or sinuses: A matter of personal habit? *Family Practice, 18*(2), 209–213.

de Vries, M., Witteman, C. L., Holland, R. W., & Dijksterhuis, A. (2010). The unconscious thought effect in clinical decision making: An example in diagnosis. *Medical Decision Making, 30*(5), 578–581. https://doi.org/10.1177/0272989X09360820

Drew, P., Chatwin, J., & Collins, S. (2001). Conversation analysis: A method for research into interactions between patients and health-care professionals. *Health Expectations, 4*(1), 58–70.

Dreyfus, H. L. (1992). *What computers still can't do: A critique of artificial reason*. Cambridge: MIT Press.

Eccles, M. P., Hrisos, S., Francis, J. J., Stamp, E., Johnston, M., Hawthorne, G., et al. (2011). Instrument development, data collection, and characteristics of practices, staff, and measures in the Improving Quality of Care in Diabetes (iQuaD) Study. *Implementation Science, 6*(1), 61. https://doi.org/10.1186/1748-5908-6-61

Evans, J. S. B. (1989). *Bias in human reasoning: Causes and consequences*. Hillsdale: Lawrence Erlbaum Associates, Inc.

Evans, J. S. (2008). Dual-processing accounts of reasoning, judgment, and social cognition. *Annual Review of Psychology, 59*, 255–278. https://doi.org/10.1146/annurev.psych.59.103006.093629

Fischer, J. E., Steiner, F., Zucol, F., Berger, C., Martignon, L., Bossart, W., et al. (2002). Use of simple heuristics to target macrolide prescription in children with community-acquired pneumonia. *Archives of Pediatrics & Adolescent Medicine, 156*(10), 1005–1008.

Flodgren, G., Eccles, M. P., Shepperd, S., Scott, A., Parmelli, E., & Beyer, F. R. (2011). An overview of reviews evaluating the effectiveness of financial incentives in changing healthcare professional behaviours and patient outcomes. *The Cochrane Library*.

Fuller, C., Michie, S., Savage, J., McAteer, J., Besser, S., Charlett, A., et al. (2012). The Feedback Intervention Trial (FIT)—Improving hand-hygiene compliance in UK healthcare workers: A stepped wedge cluster randomised controlled trial. *PLoS One, 7*(10), e41617.

Gardner, B. (2014). A review and analysis of the use of 'habit' in understanding, predicting and influencing health-related behaviour. *Health Psychology Review*, 1–19. https://doi.org/10.1080/17437199.2013.876238

Gardner, B., Abraham, C., Lally, P., & Bruijn, G. J. (2012). Towards parsimony in habit measurement: Testing the convergent and predictive validity of an automaticity subscale of the Self-Report Habit Index. *International Journal of Behavioural Nutrition and Physical Activity, 9*, 102.

Gardner, B., Phillips, L. A., & Judah, G. (2016). Habitual instigation and habitual execution: Definition, measurement, and effects on behaviour frequency. *British Journal of Health Psychology, 21*(3), 613–630.

Gardner, B., & Tang, V. (2013). Reflecting on non-reflective action: An exploratory think-aloud study of self-report habit measures. *British Journal of Health Psychology, 19*(2), 258–273.

Giguère, A., Légaré, F., Grimshaw, J., Turcotte, S., Fiander, M., & Grudniewicz, A., et al. (2012). Printed educational materials: Effects on professional practice and healthcare outcomes. *The Cochrane Library*.

Glisson, C., Schoenwald, S. K., Hemmelgarn, A., Green, P., Dukes, D., Armstrong, K. S., et al. (2010). Randomized trial of MST and ARC in a two-level evidence-based treatment implementation strategy. *Journal of Consulting and Clinical Psychology, 78*(4), 537.

Godin, G., Belanger-Gravel, A., Eccles, M., & Grimshaw, J. (2008). Healthcare professionals' intentions and behaviours: A systematic review of studies based on social cognitive theories. *Implementation Science, 3*, 36. https://doi.org/10.1186/1748-5908-3-36

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

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.

Grimshaw, J. M., Eccles, M. P., Steen, N., Johnston, M., Pitts, N. B., Glidewell, L., et al. (2011). Applying psychological theories to evidence-based clinical practice: Identifying factors predictive of lumbar spine x-ray for low back pain in UK primary care practice. *Implementation Science, 6*(1), 55.

Hagger, M. S., Luszczynska, A., de Wit, J., Benyamini, Y., Burkert, S., Chamberland, P.-E., et al. (2016). Implementation intention and planning interventions in Health Psychology: Recommendations from the Synergy Expert Group for research and practice. *Psychology & Health, 31*(7), 814–839. https://doi.org/10.1080/08870446.2016.1146719

Handoll, H. H. G., Elliott, J., Iheozor-Ejiofor, Z., Hunter, J., & Karantana, A. (2016). Interventions for treating wrist fractures in children. *Cochrane Database of Systematic Reviews*, (12). https://doi.org/10.1002/14651858.CD012470

Helfrich, C. D., Rose, A. J., Hartmann, C. W., van Bodegom-Vos, L., Graham, I. D., Wood, S. J., et al. (2018). How the dual process model of human cognition can inform efforts to de-implement ineffective and harmful clinical practices: A preliminary model of unlearning and substitution. *Journal of Evaluation in Clinical Practice, 24*(1), 198–205. https://doi.org/10.1111/jep.12855

Hofmann, W., Friese, M., & Wiers, R. W. (2008). Impulsive versus reflective influences on health behavior: A theoretical framework and empirical review. *Health Psychology Review, 2*(2), 111–137. https://doi.org/10.1080/17437190802617668

Hrisos, S., Eccles, M., Johnston, M., Francis, J., Kaner, E. F., Steen, N., et al. (2008). Developing the content of two behavioural interventions: Using theory-based interventions to promote GP management of upper respiratory tract infection without prescribing antibiotics# 1. *BMC Health Services Research, 8*(1), 11.

Ivers, N., Jamtvedt, G., Flottorp, S., Young, J. M., Odgaard-Jensen, J., French, S. D., et al. (2012). Audit and feedback: Effects on professional practice and healthcare outcomes. *The Cochrane Library*.

Johnston, D., Bell, C., Jones, M., Farquharson, B., Allan, J., Schofield, P., et al. (2015). Stressors, appraisal of stressors, experienced stress and cardiac response: A real-time, real-life investigation of work stress in nurses. *Annals of Behavioral Medicine, 50*(2), 187–197.

Kenealy, T., & Arroll, B. (2013). Antibiotics for the common cold and acute purulent rhinitis. *The Cochrane Library*.

Kwasnicka, D., Presseau, J., White, M., & Sniehotta, F. F. (2013). Does planning how to cope with anticipated barriers facilitate health-related behaviour change? A systematic review. *Health Psychology Review, 7*(2), 129–145. https://doi.org/10.1080/17437199.2013.766832

Lally, P., & Gardner, B. (2013). Promoting habit formation. *Health Psychology Review, 7*(Suppl. 1), S137–S158. https://doi.org/10.1080/17437199.2011.603640

Lally, P., van Jaarsveld, C. H. M., Potts, H. W. W., & Wardle, J. (2010). How are habits formed: Modelling habit formation in the real world. *European Journal of Social Psychology, 40*(6), 998–1009. https://doi.org/10.1002/ejsp.674

Linder, J. A., Doctor, J. N., Friedberg, M. W., Nieva, H. R., Birks, C., Meeker, D., et al. (2014). Time of day and the decision to prescribe antibiotics. *JAMA Internal Medicine, 174*(12), 2029–2031. https://doi.org/10.1001/jamainternmed.2014.5225

MacKinnon, D. P., Lockwood, C. M., & Williams, J. (2004). Confidence limits for the indirect effect: Distribution of the product and resampling methods. *Multivariate Behavioral Research, 39*(1), 99–128.

Magnabosco, J. L. (2006). Innovations in mental health services implementation: A report on state-level data from the US evidence-based practices project. *Implementation Science, 1*(1), 13.

McCleary, N., Francis, J. J., Campbell, M. K., Ramsay, C. R., Eccles, M. P., Treweek, S., et al. (2017). "Better" clinical decisions do not necessarily require more time to make. *Journal of Clinical Epidemiology, 82*, 173.

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*(1), 54.

Potthoff, S., Presseau, J., Sniehotta, F. F., Breckons, M., Rylance, A., & Avery, L. (under review). Exploring the role of competing demands and routines during the implementation of a self-management tool for type 2 diabetes: A theory-based qualitative interview study.

Potthoff, S., Presseau, J., Sniehotta, F. F., Elovainio, M., & Avery, L. (2017). Planning to be routine: Habit as a mediator of the planning-behaviour relationship in healthcare professionals. *Implementation Science, 12*, 24.

Potthoff, S., Rasul, O., Sniehotta, F. F., Marques, M. M., Beyer, F. R., Bryant, A., et al. (under review). The relationship between habit and healthcare professional behaviour in clinical practice: A systematic review and meta-analysis.

Powell, B. J., Waltz, T. J., Chinman, M. J., Damschroder, L. J., Smith, J. L., Matthieu, M. M., et al. (2015). A refined compilation of implementation strategies: Results from the Expert Recommendations for Implementing Change (ERIC) project. *Implementation Science, 10*(1), 21.

Prasad, V., & Ioannidis, J. (2014). Evidence-based de-implementation for contradicted, unproven, and aspiring healthcare practices. *Implementation Science, 9*, 1.

Preacher, K. J., & Hayes, A. F. (2008). Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behavior Research Methods, 40*(3), 879–891.

Presseau, J., Francis, J. J., Campbell, N. C., & Sniehotta, F. F. (2011). Goal conflict, goal facilitation, and health professionals' provision of physical activity advice in primary care: An exploratory prospective study. *Implementation Science, 6*, 73. https://doi.org/10.1186/1748-5908-6-73

Presseau, J., Grimshaw, J. M., Tetroe, J. M., Eccles, M. P., Francis, J. J., Godin, G., et al. (2015). A theory-based process evaluation alongside a randomised controlled trial of printed educational messages to increase primary care physicians' prescription of thiazide diuretics for hypertension [ISRCTN72772651]. *Implementation Science, 11*(1), 121.

Presseau, J., Johnston, M., Heponiemi, T., Elovainio, M., Francis, J. J., Eccles, M. P., et al. (2014). Reflective and automatic processes in health care professional behaviour: A dual process model tested across multiple behaviours. *Annals of Behavioral Medicine, 48*(3), 347–358. https://doi.org/10.1007/s12160-014-9609-8

Presseau, J., Sniehotta, F. F., Francis, J. J., & Campbell, N. C. (2009). Multiple goals and time constraints: Perceived impact on physicians' performance of evidence-based behaviours. *Implementation Science, 4*, 77. https://doi.org/10.1186/1748-5908-4-77

Reyna, V. F. (2008). A theory of medical decision making and health: Fuzzy trace theory. *Medical Decision Making, 28*(6), 850–865. https://doi.org/10.1177/0272989X08327066

Reyna, V. F., & Brainerd, C. J. (2002). Fuzzy-trace theory and false memory. *Current Directions in Psychological Science, 11*, 164–169.

Reyna, V. F., & Brainerd, C. J. (2007). The importance of mathematics in health and human judgment: Numeracy, risk communication, and medical decision making. *Learning and Individual Differences, 17*(2), 147–159. https://doi.org/10.1016/j.lindif.2007.03.010

Reyna, V. F., & Brainerd, C. J. (2011). Dual processes in decision making and developmental neuroscience: A fuzzy-trace model. *Developmental Review, 31*(2–3), 180–206. https://doi.org/10.1016/j.dr.2011.07.004

Schoenwald, S. (2010). From policy pinball to purposeful partnership: The policy contexts of multisystemic therapy transport and dissemination. *Evidence-Based Psychotherapies for Children and Adolescents, 2*, 538–553.

Shapiro, S. L., Astin, J. A., Bishop, S. R., & Cordova, M. (2005). Mindfulness-based stress reduction for health care professionals: Results from a randomized trial. *International Journal of Stress Management, 12*(2), 164.

Shojania, K. G., Jennings, A., Mayhew, A., Ramsay, C., Eccles, M., & Grimshaw, J. (2010). Effect of point-of-care computer reminders on physician behaviour: A systematic review. *Canadian Medical Association Journal, 182*(5), E216–E225.

Skinner, B. F. (1963). Operant behavior. *American Psychologist, 18*(8), 503.

Sniehotta, F. F. (2009). Towards a theory of intentional behaviour change: Plans, planning, and self-regulation. *British Journal of Health Psychology, 14*(Pt 2), 261–273. https://doi.org/10.1348/135910708X389042

Squires, J., Presseau, J., Francis, J., Bond, C. M., Fraser, C., Patey, A., et al. (2013). Self-formulated conditional plans for changing health behaviour among healthcare consumers and health professionals. *Cochrane Database of Systematic Reviews*, (12). https://doi.org/10.1002/14651858.CD010869

Stanovich, K. E., & West, R. F. (2000). Individual differences in reasoning: Implications for the rationality debate? *Behavioral and Brain Sciences, 23*(5), 645–665. https://doi.org/10.1017/S0140525X00003435

Strack, F., & Deutsch, R. (2004). Reflective and impulsive determinants of social behavior. *Personality and Social Psychology Review, 8*(3), 220–247. https://doi.org/10.1207/s15327957pspr0803_1

Strack, F., & Deutsch, R. (2014). The reflective—Impulsive model. In J. W. Sherman, B. Gawronski, & Y. Trope (Eds.), *Dual-process theories of the social mind* (pp. 92–104). New York, NY, US: Guilford Press.

Strack, F., Werth', L., & Deutsch, R. (2006). Reflective and impulsive determinants of consumer behavior. *Journal of Consumer Psychology, 16*(3), 205–216. https://doi.org/10.1207/s15327663jcp1603_2

Tannenbaum, D., Doctor, J. N., Persell, S. D., Friedberg, M. W., Meeker, D., Friesema, E. M., et al. (2015). Nudging physician prescription decisions by partitioning the order set: Results of a vignette-based study. *Journal of General Internal Medicine, 30*(3), 298–304. https://doi.org/10.1007/s11606-014-3051-2

Thomas, R. E., Vaska, M., Naugler, C., & Turin, T. C. (2015). Interventions at the laboratory level to reduce laboratory test ordering by family physicians: Systematic review. *Clinical Biochemistry, 48*(18), 1358–1365. https://doi.org/10.1016/j.clinbiochem.2015.09.014

Treweek, S., Francis, J. J., Bonetti, D., Barnett, K., Eccles, M. P., Hudson, J., et al. (2016). A primary care Web-based Intervention Modeling Experiment replicated behavior changes seen in earlier paper-based experiment. *Journal of Clinical Epidemiology, 80*, 116–122.

Verbiest, M. E. A., Presseau, J., Chavannes, N. H., Scharloo, M., Kaptein, A. A., Assendelft, W. J. J., et al. (2014). Use of action planning to increase provision of smoking cessation care by general practitioners: Role of plan specificity and enactment. *Implementation Science, 9*(1), 180. https://doi.org/10.1186/s13012-014-0180-2

Verplanken, B., & Melkevik, O. (2008). Predicting habit: The case of physical exercise. *Psychology of Sport and Exercise, 9*(1), 15–26.

Verplanken, B., & Orbell, S. (2003). Reflections on past behavior: A self-report index of habit strength. *Journal of Applied Social Psychology, 33*(6), 1313–1330.

Wood, W., & Neal, D. T. (2007). A new look at habits and the habit-goal interface. *Psychological Review, 114*(4), 843–863.

Chapter 15
Habits in Depression: Understanding and Intervention

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In this chapter we examine the potential role of habits in the onset and maintenance of major depression and how adapting psychological treatments to target habit may enhance treatment benefit. We argue that the long-standing recurrent nature of depression may reflect the habitual nature of underlying mechanisms that cause or maintain depression and, subsequently, that sustained recovery from depression may require change in these pathological habits. The role of habits in depression will be examined with reference to particular examples including depressive rumination-as-a-mental-habit and lifestyle habits such as diet.

It is estimated that approximately 1 in 5 people will experience major depression during their lifetime and that 151 million people experience major depression worldwide each year. As well as these high levels of prevalence, depression is a recurrent disorder with at least 50% of the individuals who experience one episode of depression having further episodes. Furthermore, depression is a leading cause of disability worldwide, with enormous individual, societal, and economic burden. For example, the World Health Organisation estimates that depression will be number 1 for disease burden by 2020 (Lopez, Mathers, Ezzati, Jamison, & Murray, 2006) and depression is estimated to cost €92 billion per year in Europe through health and social care costs and lost productivity. Understanding the mechanisms underpinning the onset and maintenance of depression and developing improved treatments and preventive interventions are therefore a global priority (Collins et al., 2011).

Of course, we do have effective, evidence-based treatments for depression, most notably antidepressant medications and talking therapies, such as cognitive-behavioural therapy (CBT). These treatments have been proven to be efficacious in randomised controlled trials (RCTs), outperforming pill placebo and waiting list control treatments. However, even the current best treatments for depression still

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only achieve remission rates of less than one-third and there is limited sustained recovery (Hollon, 2016; Hollon et al., 2002).

How can we improve the long-term efficacy of interventions for depression? In this chapter, we propose that considering key depressogenic behaviours, such as depressive rumination, as habits may inform our understanding of the observed patterns of recovery and relapse and suggest ways to improve long-term outcomes (Watkins & Nolen-Hoeksema, 2014). In brief, our hypothesis is that many interventions for depression improve mood in the short term and as a consequence lead to a temporary reduction in the expression of pathological habits for which low mood is the triggering stimulus, but unless the underlying habit is changed or replaced with a new more functional habit, then when the triggering context returns, the depressogenic habit is reactivated, leading to the reoccurrence of depression.

Rumination as a Mental Habit

Depressive rumination is the tendency to repetitively analyze and think about the symptoms, causes, meanings, and consequences of one's problems, concerns, and depression (Nolen-Hoeksema & Morrow, 1991; Watkins, 2008). Such rumination is often characterized by dwelling on low mood and difficulties with questions like "Why did this happen to me? Why do I feel like this? Why do I always react this way?"

Rumination is an important mechanism because it has been robustly implicated in the onset and maintenance of depression (Nolen-Hoeksema, 2000; Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008) as well as anxiety disorders, eating disorders, and substance/alcohol abuse, leading to the hypothesis that it is a transdiagnostic pathological process (Ehring & Watkins, 2008; Nolen-Hoeksema & Watkins, 2011). In large-scale longitudinal studies, rumination prospectively predicts the onset of major depressive episodes and depressive symptoms in non-depressed and currently depressed individuals, and mediates the effects of other major risk factors on depression (Kinderman, Schwannauer, Pontin, & Tai, 2013; Michl, McLaughlin, Shepherd, & Nolen-Hoeksema, 2013; Nolen-Hoeksema, 2000; Spasojevic & Alloy, 2001). In experimental studies, manipulating rumination causally exacerbates existing negative affect and negative cognition (Nolen-Hoeksema et al., 2008; Watkins, 2008).

There are two principal theoretical models of rumination: the Response Styles theory (Nolen-Hoeksema, 1991), and the Control Theory account (Carver & Scheier, 1990; Martin & Tesser, 1996). The Response Styles theory hypothesizes that depressive rumination is a stable, enduring, and habitual trait-like tendency to engage in repetitive self-focus in response to depressed mood (see Nolen-Hoeksema et al., 2008). Based on experimental research, the Response Style theory proposes that rumination is principally dysfunctional and that it causally contributes to depression by enhancing negative mood-congruent thinking, impairing problem solving, and interfering with instrumental behaviour (Nolen-Hoeksema, 1991; Nolen-Hoeksema et al., 2008).

Central to the Response Styles Theory is the assumption that rumination is a mental habit, that is, an automatic cognitive response conditioned to triggering stimuli such as low mood (Watkins & Nolen-Hoeksema, 2014). This is consistent with Hertel's conceptualization of rumination as a habit of thought that often starts automatically and involuntarily (Hertel, 2004). Because rumination occurs frequently, unintentionally, and repetitively in the same emotional context of low or depressed mood, it fulfills the usual definitions of a habit (Verplanken, Friborg, Wang, Trafimow, & Woolf, 2007; Wood & Neal, 2007). Indeed, its habitual nature is embedded within the most established measure of rumination—the Response Style Questionnaire (RSQ) (Nolen-Hoeksema & Morrow, 1991), which indexes the frequency of ruminative responses when a person is feeling sad, down, or depressed. This habitual style is hypothesized to be learnt, typically in childhood, either as a result of parents modelling a passive coping style to their children, or as a consequence of overcritical, intrusive, or overcontrolling parenting (see Spasojevic & Alloy, 2001 for evidence), early abuse (Conway, Mendelson, Giannopoulos, Csank, & Holm, 2004) or elevated life stress.

In contrast, the Control Theory account proposes that rumination is produced as a cognitive attempt to address unresolved personally important goals and that it will persist until the goal is either achieved or abandoned (Carver & Scheier, 1990; Martin & Tesser, 1996). This account of rumination does not necessarily view rumination as dysfunctional, suggesting that it can be instrumental when the repetitive thinking helps to resolve goals.

A recent integration of these two theories was proposed by Watkins and Nolen-Hoeksema (2014), building on Wood and Neal's (2007) framework to understand the relationship between goals and habits (see also Chap. 2 in this volume). This account proposed that rumination initially occurs as a goal-directed action in response to unresolved goals but that over time, if this goal-initiated rumination repeatedly occurs contingent on the same context (e.g. low mood) and tends to involve the unhelpful abstract style characteristic of depressive rumination (Watkins, 2008), then rumination can become a habit automatically triggered by low mood.

Wood and Neal (2007) emphasized that habits develop through a process of automatic association between a behaviour and any context that occurs repeatedly with performance of that same behaviour. Thus, any response repeated frequently that is contingent on a particular context can result in the development of a habitual response to that context, consistent with classic stimulus–response theories of learning (see Dickinson, 1985).

For rumination, this means that individuals experiencing repeated and extended periods of unresolved goals, associated with low mood, such as those experiencing chronic stress or emotional, physical, or sexual abuse and neglect, are likely to learn an association between feeling sad and the initiation of repetitive analytical thinking. If this thinking is further characterized by analyzing the meaning and implications of events and feelings, rather than more adaptive concrete thinking and problem-solving (Watkins, 2008), the individual develops an unhelpful mental habit of rumination. As a consequence, context cues become automatic triggers for the behaviour, such that it is controlled by the presence or absence of the cue rather than by individual goals—in this case, rumination triggered by low mood.

Consistent with this model, depressive ruminators report that rumination occurs without conscious intent, and that they are unable to control it (Watkins & Baracaia, 2001). Moreover, rumination is associated with self-reported lack of conscious awareness, lack of deliberate intent, and difficulties in controlling negative thinking (Verplanken et al., 2007). Critically, self-report of the habitual nature of negative thinking predicts additional variance in future depression above measures of negative thinking content alone (Verplanken et al., 2007), indicating the predictive value of considering habit.

Wood and Neal (2007, p. 844) further argued that because "habits arise from context-response learning that is acquired slowly with experience… habit dispositions do not alter in response to people's current goals or occasional counter-habitual responses". In other words, once developed, habits are resistant to changes in goals, outcomes, and intentions, and difficult to stop or change because control of the habit is outsourced directly to the contextual cues paired with the past enactment of the behaviour rather than mediated by goals or outcomes. This is also consistent with the observation that rumination is hard to stop, even when patients are aware of its negative consequences and it is in conflict with their goals and beliefs.

Conceptualizing rumination-as-a-mental-habit also has a number of treatment implications for depression (for full details see Watkins & Nolen-Hoeksema, 2014). First, interventions focused on changing individual's beliefs, attitudes, and intentions and providing new information are not typically effective at changing habitual behaviours (Verplanken & Wood, 2006; Webb & Sheeran, 2006) because they do not directly address the pattern of context-response learning. As such, many common elements of psychological interventions such as psychoeducation, changing goals, and cognitive restructuring would not alone be expected to be that successful at changing depressive rumination, because they do not tackle its habitual quality. Consistent with this, there is emerging evidence that rumination predicts worse outcomes to talking therapies (Jones, Siegle, & Thase, 2008; Schmaling, Dimidjian, Katon, & Sullivan, 2002).

Instead of these traditional psychotherapeutic approaches, it may be that proven approaches to changing habits could be usefully adapted to treating or preventing rumination. Effective habit change techniques effectively fall into two classes: (a) disrupting the environmental factors (e.g. time, place, internal state, behavioural routine) that automatically cue the habit (Verplanken & Wood, 2006), or (b) counterconditioning an alternative incompatible response to the triggering cues of the habit, that is, learning a new more helpful habit to enact to the same cues as the original habit (Hertel, 2004; Marteau, Hollands, & Fletcher, 2012; Wood & Neal, 2007).

Thus, for a treatment to be effective in reducing rumination, the unhelpful ruminative response to the cueing context needs to be replaced with a more helpful response, with the patient learning a new, more adaptive habit. Such an intervention involves repeated practice at utilizing an alternative incompatible coping strategy (e.g. concrete thinking, relaxation) in response to the triggering cue (e.g. sad mood) to develop the new context-response association. A similar argument was made by Hertel (2004, p. 209) who recommended "the training of new habits through practice in control". We further explore these approaches in a later section.

Second, we know that old habits tend to reoccur when an individual returns to an old context, when they are fatigued, under stress, or experiencing cognitive load (Bouton, 2000; Schwabe & Wolf, 2011). These are of course exactly the situations that predispose an individual to rumination, as well as the situations where rumination is most deleterious and where we most want to reduce it.

Finally, Watkins and Nolen-Hoeksema (2014) hypothesized that the extent to which the underlying habit of rumination is changed could account for whether an intervention has short-term or sustained long-term benefit in reducing depression. Watkins and Nolen-Hoeksema (2014) predicted that any interventions that improve mood state will temporarily disrupt depressive rumination by removing the context (i.e. low mood) that triggers the ruminative habit and, thereby, limit its expression. However, once the triggering context returns during another period of depressed mood or stress, the ruminative habit would be reactivated, increasing vulnerability to another episode of depression. In contrast, only interventions that directly modify the context–response association will lead to long-standing reductions in depressive rumination and the associated depressive vulnerability.

Because many psychological interventions for depression improve symptoms in the short term through positive expectancy, remoralization, increased activation, and therapist support, but do not directly target depressogenic habits like rumination, this analysis predicts that they would temporarily reduce rumination but also leave patients vulnerable to relapse. Watkins and Nolen-Hoeksema (2014) argued that this failure to address the underlying mental habit can partially explain the high rates of relapse and recurrence and the limited sustained recovery observed in treating depression. A testable prediction is that post-treatment measures indexing habit strength for rumination will improve our predictions of sustained recovery from major depression than post-treatment beliefs, expectancies, and symptoms alone.

Treating Rumination-as-a-Habit

The conceptualization of rumination as a mental habit has also fundamentally informed the development of rumination-focused cognitive-behavioural therapy (RFCBT), a variant of CBT explicitly designed to specifically target rumination (Watkins, 2016; Watkins et al., 2011). The core principles and rationale of the therapy are all focused on engendering habit change.

RFCBT appears to be an efficacious treatment and prevention intervention. It was first evaluated in a RCT of 42 patients with medication-refractory residual depression that compared ongoing antidepressant medication and outpatient clinical management (treatment-as-usual, TAU) versus TAU plus individualized RFCBT

(Watkins et al., 2011). Adding RFCBT to TAU significantly reduced rumination and depression relative to TAU alone (remission rates: TAU 21%; TAU + RFCBT 62%), comparing favourably to the effects of adding standard CBT to TAU for patients with residual depression in a separate RCT (remission rates 25%) (Paykel et al., 1999). Change in rumination mediated the effect of treatment condition on depression, although this was only measured concurrently, preventing conclusions about causal direction.

An independent trial found that group-delivered RFCBT improved depressed mood and reduced rumination relative to a waiting list condition in patients with residual depression, with treatment gains maintained over 1-year follow-up (Teismann et al., 2014). In an as yet unpublished trial with colleagues in Denmark, we compared group-delivered RFCBT versus group-delivered traditional CBT for outpatients with major depression, and found that group RFBCT reduced symptoms of depression significantly more than group CBT (see Hvenegaard et al., 2015 for trial protocol).

A RCT comparing group and internet versions of RFCBT found that both RFCBT adaptations were effective relative to waiting-list control groups for reducing depression, anxiety, worry, and rumination in young adults selected for elevated worry and rumination, in a high-risk prevention intervention design conducted in Amsterdam (Topper, Emmelkamp, Watkins, & Ehring, 2017). There were no differences between the group and internet online versions of RFCBT on any of the outcome measures, with both resulting in significantly lower 1-year incidence rates of major depression (group RFCBT 15.3%, internet RFCBT 14.7%) and generalized anxiety disorder (group RFCBT 18%; internet RFCBT 16%), relative to waiting list (32.4% and 42.2%, respectively). These results provide proof of principle that rumination increases the risk for the onset of major depression and generalized anxiety disorder, and that targeting worry and rumination can reduce the onset of depression and anxiety. However, to date, RFCBT has not been compared to traditional CBT in a large-scale prevention or intervention trial, nor have we decomposed the active ingredients of the therapy.

Central to RFCBT is the use of a functional–analytic and contextual approach as developed in Behavioural Activation (BA) (Dimidjian, Barrera, Martell, Munoz, & Lewinsohn, 2011; Jacobson, Martell, & Dimidjian, 2001). Within this approach, rumination is conceptualized as a learned habitual behaviour that develops through negative reinforcement. Functional analysis examines how, when, with whom and where a target behaviour (e.g. rumination) does and does not occur, and its antecedents and consequences, to formulate its possible functions and to make plans that systematically reduce or replace it. By focusing on identifying antecedents to rumination, this approach explicitly spots the warning signs and triggers that may cue the habitual rumination, and makes both therapist and patient aware of the triggers to the habit. The functional analytic approach then explicitly uses the principles of successful habit change outlined above: once a trigger to rumination is identified, the trigger is either removed or replaced if possible, for example, by changing behavioural routines, or contingency plans are made to repeatedly practice alternative helpful responses in order to learn a new more helpful habit (see also Chap. 9 in this volume). This focus on identifying the warning signs is made explicit in Principle 5 of RFCBT: “Link behaviour to warning signs”.

The alternative behaviours that could be practised are any within the standard CBT repertoire, including activity scheduling, relaxation, assertiveness training, problem solving, etc. However, critical to the RFCBT formulation, and consistent with facilitating habit change, the alternative behaviour is selected to ensure that it is not only incompatible with unhelpful rumination, but also that it is within the patient’s existing behavioural repertoire and likely to be helpful and rewarding. In other words, the alternative behaviour is chosen to be reinforcing and likely to become routine for the patient, optimizing its chance of becoming a new habit.

RFCBT and BA assume that rumination may be maintained as a habit because there has been a history of negative reinforcement in which the rumination acts as a form of avoidance to minimize further distress. For example, for some patients ruminating about how they are being selfish and oversensitive may make them feel down and self-critical whilst also reducing the original irritation and anger that triggered the rumination. If for the individual, anger is experienced as more distressing than the low mood produced by rumination, then rumination is a way of avoiding anger and is negatively reinforced. Here, the useful alternative behaviour to be practised needs to be another way to reduce anger, which will be reinforcing to the individual but without the downside of depressive rumination, such as a combination of progressive muscle relaxation and assertiveness practice. The intention is that with repetition this behaviour replaces the ruminative habit.

Rumination is also often viewed by patients as an attempt to solve a problem or to understand a difficulty in order to prevent it reoccurring (Watkins & Baracaia, 2001), although this strategy is often unsuccessful. In part this is because pathological rumination typically involves an abstract, decontextualized, and global thinking style, focused on causes, meanings and implications (e.g. asking “Why me?” “What does this mean?”), which in experiments has been shown to causally contribute to maladaptive consequences such as poor problem-solving and increased emotional reactivity, in contrast to a concrete, specific, and contextualized style (e.g. asking “How did this happen?”) (Watkins, Moberly, & Moulds, 2008; Watkins & Moulds, 2005).

Based on this research, RFCBT also uses functional analysis to help patients to spot when their thinking may be helpful versus unhelpful and to then shift them to systematically use the more helpful style of thinking. This includes repeated training in shifting thinking into a more concrete and specific thinking style, and the use of guided imagery to recreate previous mental states when a thinking style directly counter to rumination was active, including memories of being completely absorbed in an activity (e.g. “flow” experiences), and experiences of increased compassion to self or others.

This training to think in a more concrete and specific way has been tested as a distinct treatment intervention in its own right, providing some evidence consistent with the value of conceptualising rumination-as-a-mental-habit. An initial RCT found that training dysphoric individuals to be more concrete when faced with difficulties reduced depression, anxiety, and rumination relative to a no-treatment control over 1 week (Watkins, Baeyens, & Read, 2009). Concreteness training involved repeated practice at focusing on the specific details, context, and sequence of difficult events, and asking "How the event happened?" During the training, concrete thinking is explicitly used as a response to warning signs for rumination and is practiced repeatedly with audio-recorded exercises.

A further trial in patients with depression recruited in primary care found that adding concreteness training to TAU (whatever was provided by the GP; antidepressants for 50% of patients) did better than TAU in reducing rumination, worry, and depression (Watkins et al., 2012). Here, the training exercises were practised daily for 6 weeks, with therapist contact only consisting of one initial face-to-face session to learn the technique and several brief phone-calls to encourage repeated practice. A control training condition, in which patients practiced progressive relaxation as an alternative response to cues for rumination, also significantly reduced depression relative to TAU and did not significantly differ from concreteness training. However, whilst both concreteness training and relaxation training were equally effective at reducing depression, only concreteness training significantly reduced trait rumination. These results suggest that identifying the trigger to an unhelpful depressogenic habit and repeatedly practising an alternative response may help to reduce depression, but only using a cognitive alternative directly linked to the thinking style characteristic of rumination reduced rumination. Moreover, consistent with the hypothesis that concreteness training works through establishing an alternative habitual response, the treatment benefits of concreteness training were significantly stronger in those patients who reported that the practiced self-help response had become habitual (Watkins et al., 2012).

Within both RFCBT and concreteness training, the practice of these new alternative behaviours is explicitly designed to counter-condition a new more helpful response to rumination-triggering cues. As such, it is recognized that learning new habits will require repeated practice over multiple occasions of alternative responses to the cues that normally trigger rumination. Plans are made with this need for repeated practice in mind. This is reflected in Principle 6 of RFCBT: "Emphasize the importance of repetition and practice".

The therapy rationale also makes explicit to the patient that rumination is conceptualized as a habit. The therapist explains that like any habit, rumination is often automatic and triggered by internal and external cues, often outside of awareness. The therapist also explains that like any habit, rumination will be hard to change at first and will tend to recur when the patient is stressed or tired, and there will be periods when rumination comes back, and this is natural and not something the patient should criticize herself for when it happens. Instead, patients should be encouraged to just gently return to the new strategies they have learned and to see this as a further opportunity to practice breaking the habit.

Our clinical impression is that the language of "habits" is very helpful to patients because it is simple, approachable, makes sense, and reduces stigma. Everyone can think of examples of having good habits and bad habits and can understand what it might take to change a habit, such as awareness of when it is happening and the need for repeated practice. It also helps patients to consider rumination as something that is distinct from their personality and potentially amenable to change. Talking about habits also helps to make sense of the difficulties in changing rumination and prevents recurrences of the habit from causing self-criticism. It also logically leads into plans to monitor and look out for warning signs and to become more aware of the habit as the first step within treatment.

The approach taken within RFCBT to implement new plans to break out of the habit of rumination builds on the literature on effective habit change. Once patients have identified warning signs for rumination, a key step is to generate explicit "IF-THEN" plans to use when they notice these signs to interrupt and cut off rumination, and to replace it with a more helpful strategy. These plans are of the form: "If I notice this warning sign, then I perform this alternative response instead of rumination". These plans incorporate the findings on implementation intentions (see also Chaps. 10 and 16 in this volume), in which linking an event (warning sign), routine behaviour, or a specific time and place to the enaction of a new behaviour is shown to increase automaticity, reduce the mental effort required to implement the plan, and help to establish new habits (Brandstatter, Lengfelder, & Gollwitzer, 2001; Gollwitzer & Brandstatter, 1997; Gollwitzer & Sheeran, 2006; Holland, Aarts, & Langendam, 2006). One particular approach to making implementation intention involves making plans that take the form "If situation *X* is encountered, then I will perform behaviour *Y*". By making plans linked to the environment, individuals become more consistent in enacting plans, and they begin to assert some control over what they do, rather than letting feelings dictate. For all these reasons, RFBCT uses If–Then implementation intention plans as the simplest and most memorable way to make contingency plans to replace rumination (for more detail on habits in pathology in general and for the use of implementation intentions in mental health see Chap. 16 in this volume).

In summary, RFCBT has been found to be effective at reducing rumination and treating and preventing depression, and targeting rumination-as-a-mental-habit is central to its key principles and techniques. Whilst there is preliminary evidence that this approach may improve treatment outcomes for depression, there is not yet evidence that any treatment benefits accrued are due to the focus on treating rumination-as-a-habit, nor that this approach has long-term benefit, as hypothesized by Watkins and Nolen-Hoeksema (2014). Key next steps are to consistently assess rumination-as-a-habit [see the 'Habit Research in Action' box] and to evaluate whether change in habit mediates short and long-term treatment outcomes and, critically, whether it adds to our explanatory power in understanding treatment effects, and, to decompose and manipulate elements within RFCBT to test if the habitual focus contributes to treatment benefit.

We note that rumination is probably not the only common behaviour in depression that could be characterized as a habit. An obvious candidate is avoidance, which is a typical depressive response, whether it takes the form of reduced activity, withdrawal from others, not trying new things, or retreating to bed. Like rumination, avoidance may be triggered by particular cues for each individual, e.g. increased tiredness or anxiety, and is likely to be negatively reinforced by temporarily reducing distress. Indeed, BA conceptualizes avoidance in these terms. However, the habitual quality of avoidance in depression to our knowledge has not yet been formally assessed with respect to its automaticity and being triggered by specific stimulus cues.

Lifestyle Habits and Depression

Another set of behaviours that are likely to be habits associated with the onset and maintenance of depression are lifestyle habits including eating habits and exercise. There is robust evidence that physical and mental health are not independent. For example, there is extensive evidence of co-morbidity between depression and cardiovascular disease (Cohen, Edmondson, & Kronish, 2015; Penninx, 2017), diabetes (Mezuk, Eaton, Albrecht, & Golden, 2008), and obesity (Hryhorczuk, Sharma, & Fulton, 2013). Depression prospectively predicts increased risk for obesity, and vice versa (Luppino et al., 2010; Mannan, Mamun, Doi, & Clavarino, 2016; Pan et al., 2012), leading to the hypothesis that the relationship between weight and depression is bi-directional. Research also suggests that there is a dose-response relationship between unhealthy habitual behaviours such as smoking, drinking alcohol, and being physically inactive and the severity of depression (Strine et al., 2008).

Diet is one important element identified as a common factor between depression and obesity. Both depression and obesity are associated with poorer diet quality (Sanchez-Villegas et al., 2015; Sundararajan, Campbell, Choi, & Sarma, 2014) including the consumption of less healthy food such as fruit and vegetables, and increased consumption of fatty and sugar-rich foods (Appelhans et al., 2012). Recent evidence suggests that better diet quality is predictive of lower incidence of depression over time (Molendijk, Molero, Ortuno Sanchez-Pedreno, Van der Does, & Angel Martinez-Gonzalez, 2018). Stress-driven eating is also associated with eating more energy-dense high-fat foods and obesity (Laitinen, Ek, & Sovio, 2002), which may partly explain the association between depression and chronic diseases such as diabetes (Knol et al., 2006), obesity (de Wit et al., 2010) and cardiovascular disease (Seldenrijk et al., 2011).

Indeed, there is now growing research evidence to support the idea that healthy diets, nutrition, and food-related behavioural habits play a role in the prevention of depression. For example, adhering to a diet rich in fruit, vegetables, fish, and olive oil (sometimes called a “Mediterranean-style diet”) may act as a treatment for those currently suffering from depression (Jacka et al., 2017) as well as a protective factor against developing depression (Lai et al., 2014; Sanchez-Villegas et al., 2013; Sanchez-Villegas & Martinez-Gonzalez, 2013). Conversely, a diet largely made up of heavily processed nutrient-poor foods, sugary products, and saturated fats (increasingly frequent in the Western diet) may be related to an increased risk of depression (Li et al., 2017; Rahe, Unrath, & Berger, 2014).

Research also suggests that lifestyle interventions involving the promotion of healthy eating habits may be beneficial in preventing depression (see meta-anlaysis by Fabricatore et al., 2011). The extant research suggests that just as habit change may be the key ingredient in maintaining weight loss (Cleo, Isenring, Thomas, & Glasziou, 2017), the promotion of healthy eating practices may be beneficial in preventing depression by encouraging healthy habits that lead to lasting behavioural change.

The role of diet and nutrition as a potential risk factor in the onset of major depression is being investigated in the MooDFOOD trial, funded by the European Commission FP7 scheme (Roca et al., 2016). In this prevention trial, 1025 participants from the Netherlands, UK, Spain, and Germany, who have a BMI $\geq$25 kg/m^2 and elevated sub-syndromal symptoms of depression are being randomized in a 2×2 factorial design to nutritional supplements vs pill placebo and to a food-related behavioural change intervention versus no food-related behavioural change intervention, and followed up for 12 months. The food-related behavioural change intervention is intended to increase the regular consumption of a "Mediterranean-style" diet. The trial therefore tests whether changing nutrition, either directly through food supplements or by changing behaviour can reduce depression in an at-risk overweight group.

Critically, when planning the behavioural intervention to change diet, it was recognized that patterns of eating and diet are often habitual. Indeed, habit is one of the most powerful predictors of eating behaviour (van't Riet, Sijtsema, Dagevos, & De Bruijn, 2011). Moreover, patterns of eating behaviour may also be linked to emotional state, such as comfort eating and emotional eating, which may in turn lead to cycles of weight gain and depression (van Strien, Konttinen, Homberg, Engels, & Winkens, 2016).

The food-related behavioural change intervention therefore explicitly adopted a habit change perspective. Indeed, the intervention explicitly and deliberately follows the same principles and techniques outlined earlier for RFCBT and BA, adopting a functional–analytical perspective and explicitly discussing habit change with clients, but expanding to food-related and mood-related habits as well as rumination or avoidance. Thus, each participant identifies an unhealthy habit they would like to decrease (typically to reduce some form of unhealthy eating) and a healthy habit they would like to increase (typically increasing exercise), and then works with the therapist to make plans to enact these habits, as well as habits linked to increasing a Mediterranean style diet.

As in RFCBT, specific examples of healthy and unhealthy habits are analyzed to identify their antecedents and consequences, and alternative behaviours are identified and then practised using IF-THEN implementation intention plans. For example, plans may be made to build healthy eating into a routine by establishing a pattern of three regular meals a day. For example, if eating unhealthy snacks is triggered by feeling sad or bored, plans are made to identify a reinforcing alternative behaviour to practise to those feelings, whether it be eating a healthy snack such as nuts or fruit, or doing something positive to improve mood such as calling a friend or going for a walk. In other words, the goal is to use behavioural and learning principles to shift the participant into building up a more healthy habit.

The MooDFOOD trial will therefore test whether an intensive psychotherapeutic approach building on habit principles is effective at changing lifestyle habits and whether these lifestyle changes can prevent depression. Again, like the RESPOND trial (see box), indices of habit change are also included in the trial. The MooDFOOD consortium will report their findings in 2018.

One interesting preliminary finding is that unhelpful habits tend to be associated with each other: data from the baseline MooDFOOD measures indicate that self-reported rumination is associated with increased automaticity and frequency of eating an unhealthy fatty and sugary diet, as assessed using a Self-Report Habit Index measure of "Eating a diet high in sugar and fats (e.g. sweets, crisps, biscuits, chocolates, ice cream, fizzy drinks, cake, fast food) is something…" [see the 'Habit Research in Action' box, also see Chap. 3 in this volume for greater description of Self-Report Habit Index]. We found that the higher the levels of avoidance and rumination, the more automatic and frequent the unhealthy, fatty and sugary diet was ($B = -.24$, bootstrapped (1000) SE = .04, $p < .001$, 95% CI = −.31 to −.17). This observation is consistent with a recent meta-analysis which found that perseverative thought, and in particular, rumination was associated with unhealthy behaviours such as smoking, drinking alcohol, less exercise and poor diet (Clancy, Prestwich, Caperon, & O'Connor, 2016). These associations raise the possibility that successful change in one habit may impact other habits.

Conclusion

There is growing evidence that important processes linked to the onset and maintenance of depression, such as depressive rumination and unhealthy lifestyle behaviours can be usefully conceptualized as habits. An intervention that explicitly and deliberately targets rumination-as-a-mental-habit has been shown to be an efficacious treatment for hard-to-treat depression and an effective prevention intervention in high-risk groups. A similar habit-focused intervention is currently being tested to prevent depression whilst incorporating broader lifestyle change. However, to date, key questions about whether these interventions work through the mechanism of targeting habits and whether assessing habit change can improve prediction of treatment outcome remain unresolved. Nonetheless, we are hopeful that the multiple large-scale trials we are currently conducting will begin to answer these questions.

Habit Research in Action: Tools for Investigating Habits

Because rumination is an internal and subjective experience, it is hard to assess it without some involving self-report, especially when we are testing large numbers of people in clinical trials. Further, there are not reliable behavioural proxies to assess rumination. We are therefore exploring self-report measures to examine the habitual quality of rumination. In particular, we are examining whether we can usefully adapt the Self-Report Habit Index (SRHI), which measures the frequency and automaticity of behaviour to examine rumination. The SRHI asks participants to rate how much a particular behaviour, for example, rumination (e.g. "Over the last 2 weeks, worry and rumination is something") has been automatic (four items including "I do automatically", "I do unintentionally", "I do without thinking", "I start doing before I realize I am doing it"), rated on a scale from "strongly agree" to "strongly disagree". We have focused on the automaticity aspect of the measure to avoid confounds with the existing rumination measure (RSQ). The original measure has good reliability and validity predicting actual habitual behaviour (Gardner, Abraham, Lally, & de Bruijn, 2012; Orbell & Verplanken, 2010), and is adaptable for different behaviours.

Whilst people are often unaware of habits at the point of doing them—as a function of their automatic and unconscious nature—it is proposed that people can be aware of their tendency towards a habitual response over time as an aggregate of their recollected memory. We have also adapted the SRHI in MooDFOOD to assess how habitual eating a healthy Mediterranean style diet is relative to eating a fat, sugar, and carbohydrate-rich diet, and to capture the strength of the unhealthy and healthy habits that participants want to respectively decrease and increase. We are currently assessing whether these adaptations may be psychometrically valid and reliable, whether they are sensitive to treatment, and whether they improve our predictions of longer-term outcomes in depression, in large-scale internet trials of cognitive behavioural therapy for depression. For example, in our RESPOND study (Cook & Watkins, 2016), we are examining whether we can replicate and extend the Topper et al. (2017) finding that internet-delivered RFCBT prevents major depression in high-risk young people, to high ruminating UK undergraduates. We have replaced the group version of RFCBT with an unguided self-help internet RFCBT to test whether the prevention treatment can be made more scalable, used structured clinical interviews instead of questionnaire cut-offs for diagnosis and included self-report measures of habitual negative thinking. We will first test that these measures provide convergent and divergent validity with other measures of rumination and lifestyle behaviours, and then see if they account for more variance in depression outcomes.

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References

Appelhans, B. M., Whited, M. C., Schneider, K. L., Ma, Y., Oleski, J. L., Merriam, P. A., et al. (2012). Depression severity, diet quality, and physical activity in women with obesity and depression. *Journal of the Academy of Nutrition and Dietetics, 112*(5), 693–698. https://doi.org/10.1016/j.jand.2012.02.006

Bouton, M. E. (2000). A learning theory perspective on lapse, relapse, and the maintenance of behavior change. *Health Psychology, 19*(1), 57–63. https://doi.org/10.1037//0278-6133.19.Suppl1.57

Brandstatter, V., Lengfelder, A., & Gollwitzer, P. M. (2001). Implementation intentions and efficient action initiation. *Journal of Personality and Social Psychology, 81*(5), 946–960. https://doi.org/10.1037//0022-3514.81.5.946

Carver, C. S., & Scheier, M. F. (1990). Origins and functions of positive and negative affect—A control process view. *Psychological Review, 97*(1), 19–35.

Clancy, F., Prestwich, A., Caperon, L., & O'Connor, D. B. (2016). Perseverative cognition and health behaviors: A systematic review and meta-analysis. *Frontiers in Human Neuroscience, 10*, 534. https://doi.org/10.3389/fnhurn.2016.00534

Cleo, G., Isenring, E., Thomas, R., & Glasziou, P. (2017). Could habits hold the key to weight loss maintenance? A narrative review. *Journal of Human Nutrition and Dietetics, 30*(5), 655–664. https://doi.org/10.1111/jhn.12456

Cohen, B. E., Edmondson, D., & Kronish, I. M. (2015). State of the art review: Depression, stress, anxiety, and cardiovascular disease. *American Journal of Hypertension, 28*(11), 1295–1302. https://doi.org/10.1093/ajh/hpv047

Collins, P. Y., Patel, V., Joestl, S. S., March, D., Insel, T. R., Daar, A. S., et al. (2011). Grand challenges in global mental health. *Nature, 475*(7354), 27–30. https://doi.org/10.1038/475027a

Conway, M., Mendelson, M., Giannopoulos, C., Csank, P. A. R., & Holm, S. L. (2004). Childhood and adult sexual abuse, rumination on sadness, and dysphoria. *Child Abuse & Neglect, 28*(4), 393–410. https://doi.org/10.1016/j.chiabu.2003.05.004

Cook, L., & Watkins, E. (2016). Guided, internet-based, rumination-focused cognitive behavioural therapy (i-RFCBT) versus a no-intervention control to prevent depression in high-ruminating young adults, along with an adjunct assessment of the feasibility of unguided i-RFCBT, in the REducing Stress and Preventing Depression trial (RESPOND): Study protocol for a phase III randomised controlled trial. *Trials, 17*, 11. https://doi.org/10.1186/s13063-015-1128-9

de Wit, L., Luppino, F., van Straten, A., Penninx, B., Zitman, F., & Cuijpers, P. (2010). Depression and obesity: A meta-analysis of community-based studies. *Psychiatry Research, 178*(2), 230–235. https://doi.org/10.1016/j.psychres.2009.04.015

Dickinson, A. (1985). Actions and habits: The development of behavioural autonomy. *Philosophical Transactions of the Royal Society London B, 308*(1135), 67–78.

Dimidjian, S., Barrera, M., Martell, C., Munoz, R. F., & Lewinsohn, P. M. (2011). The origins and current status of behavioral activation treatments for depression. In S. NolenHoeksema, T. D. Cannon, & T. Widiger (Eds.), *Annual review of clinical psychology* (Vol. 7, pp. 1–38). Palo Alto: Annual Reviews.

Ehring, T., & Watkins, E. R. (2008). Repetitive negative thinking as a transdiagnostic process. *International Journal of Cognitive Therapy, 1*(3), 192–205. https://doi.org/10.1680/ijct.2008.1.3.192

Fabricatore, A. N., Wadden, T. A., Higginbotham, A. J., Faulconbridge, L. F., Nguyen, A. M., Heymsfield, S. B., et al. (2011). Intentional weight loss and changes in symptoms of depression: A systematic review and meta-analysis. *International Journal of Obesity, 35*(11), 1363–1376. https://doi.org/10.1038/ijo.2011.2

Gardner, B., Abraham, C., Lally, P., & de Bruijn, G.-J. (2012). Towards parsimony in habit measurement: Testing the convergent and predictive validity of an automaticity subscale of the Self-Report Habit Index. *International Journal of Behavioral Nutrition and Physical Activity, 9*, 102. https://doi.org/10.1186/1479-5868-9-102

Gollwitzer, P. M., & Brandstatter, V. (1997). Implementation intentions and effective goal pursuit. *Journal of Personality and Social Psychology, 73*(1), 186–199. https://doi.org/10.1037/0022-3514.73.1.186

Gollwitzer, P. M., & Sheeran, P. (2006). Implementation intentions and goal achievement: A meta-analysis of effects and processes. In M. P. Zanna (Ed.), *Advances in experimental social psychology* (Vol. 38, pp. 69–119).

Hertel, P. T. (2004). Memory for emotional and nonemotional events in depression. *Memory and Emotion,* 186–216.

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*(6), 776–783. https://doi.org/10.1016/j.jesp.2005.11.006

Hollon, S. D. (2016). The efficacy and acceptability of psychological interventions for depression: Where we are now and where we are going. *Epidemiology and Psychiatric Sciences, 25*(4), 295–300. https://doi.org/10.1017/s2045796015000748

Hollon, S. D., Munoz, R. F., Barlow, D. H., Beardslee, W. R., Bell, C. C., Bernal, G., et al. (2002). Psychosocial intervention development for the prevention and treatment of depression: Promoting innovation and increasing access. *Biological Psychiatry, 52*(6), 610–630. https://doi.org/10.1016/s0006-3223(02)01384-7

Hryhorczuk, C., Sharma, S., & Fulton, S. E. (2013). Metabolic disturbances connecting obesity and depression. *Frontiers in Neuroscience, 7*, 177. https://doi.org/10.3389/fnins.2013.00177

Hvenegaard, M., Watkins, E. R., Poulsen, S., Rosenberg, N. K., Gondan, M., Grafton, B., et al. (2015). Rumination-focused cognitive behaviour therapy vs. cognitive behaviour therapy for depression: Study protocol for a randomised controlled superiority trial. *Trials, 16*, 6. https://doi.org/10.1186/s13063-015-0875-y

Jacka, F. N., O'Neil, A., Opie, R., Itsiopoulos, C., Cotton, S., Mohebbi, M., et al. (2017). A randomised controlled trial of dietary improvement for adults with major depression (the 'SMILES' trial). *BMC Medicine, 15*, 23. https://doi.org/10.1186/s12916-017-0791-y

Jacobson, N. S., Martell, C. R., & Dimidjian, S. (2001). Behavioral activation treatment for depression: Returning to contextual roots. *Clinical Psychology: Science and Practice, 8*(3), 255–270. https://doi.org/10.1093/clipsy/8.3.255

Jones, N. P., Siegle, G. J., & Thase, M. E. (2008). Effects of rumination and initial severity on remission to cognitive therapy for depression. *Cognitive Therapy and Research, 32*(4), 591–604. https://doi.org/10.1007/s10608-008-9191-0

Kinderman, P., Schwannauer, M., Pontin, E., & Tai, S. (2013). Psychological processes mediate the impact of familial risk, social circumstances and life events on mental health. *PLoS One, 8*(10), 8. https://doi.org/10.1371/journal.pone.0076564

Knol, M. J., Twisk, J. W. R., Beekman, A. T. F., Heine, R. J., Snoek, F. J., & Pouwer, F. (2006). Depression as a risk factor for the onset of type 2 diabetes mellitus. A meta-analysis. *Diabetologia, 49*(5), 837–845. https://doi.org/10.1007/s00125-006-0159-x

Lai, J. S., Hiles, S., Bisquera, A., Hure, A. J., McEvoy, M., & Attia, J. (2014). A systematic review and meta-analysis of dietary patterns and depression in community-dwelling adults. *The American Journal of Clinical Nutrition, 99*(1), 181–197. https://doi.org/10.3945/ajcn.113.069880

Laitinen, J., Ek, E., & Sovio, U. (2002). Stress-related eating and drinking behavior and body mass index and predictors of this behavior. *Preventive Medicine, 34*(1), 29–39. https://doi.org/10.1006/pmed.2001.0948

Li, Y., Lv, M. R., Wei, Y. J., Sun, L., Zhang, J. X., Zhang, H. G., et al. (2017). Dietary patterns and depression risk: A meta-analysis. *Psychiatry Research, 253*, 373–382. https://doi.org/10.1016/j.psychres.2017.04.020

Lopez, A. D., Mathers, C. D., Ezzati, M., Jamison, D. T., & Murray, C. J. L. (2006). Global and regional burden of disease and risk factors, 2001: Systematic analysis of population health data. *Lancet, 367*(9524), 1747–1757. https://doi.org/10.1016/s0140-6736(06)68770-9

Luppino, F. S., de Wit, L. M., Bouvy, P. F., Stijnen, T., Cuijpers, P., Penninx, B., et al. (2010). Overweight, obesity, and depression: a systematic review and meta-analysis of longitudinal studies. *Archives of General Psychiatry, 67*(3), 220–229.

Mannan, M., Mamun, A., Doi, S., & Clavarino, A. (2016). Is there a bi-directional relationship between depression and obesity among adult men and women? Systematic review and bias-adjusted meta analysis. *Asian Journal of Psychiatry, 21*, 51–66. https://doi.org/10.1016/j.ajp.2015.12.008

Marteau, T. M., Hollands, G. J., & Fletcher, P. C. (2012). Changing human behavior to prevent disease: The importance of targeting automatic processes. *Science, 337*(6101), 1492–1495. https://doi.org/10.1126/science.1226918

Martin, L., & Tesser, A. (1996). Some ruminative thoughts. In R. S. Wyer (Ed.), *Ruminative thoughts: Advances in social cognition* (Vol. IX, pp. 1–47). Mahwah, NJ: Erlbaum.

Mezuk, B., Eaton, W. W., Albrecht, S., & Golden, S. H. (2008). Depression and type 2 diabetes over the lifespan: A meta-analysis. *Diabetes Care, 31*(12), 2383–2390. https://doi.org/10.2337/Dc08-0985

Michl, L. C., McLaughlin, K. A., Shepherd, K., & Nolen-Hoeksema, S. (2013). Rumination as a mechanism linking stressful life events to symptoms of depression and anxiety: Longitudinal evidence in early adolescents and adults. *Journal of Abnormal Psychology, 122*(2), 339–352. https://doi.org/10.1037/a0031994

Molendijk, M., Molero, P., Ortuno Sanchez-Pedreno, F., Van der Does, W., & Angel Martinez-Gonzalez, M. (2018). Diet quality and depression risk: A systematic review and dose-response meta-analysis of prospective studies. *Journal of Affective Disorders, 226*, 346–354. https://doi.org/10.1016/j.jad.2017.09.022

Nolen-Hoeksema, S. (1991). Responses to depression and their effects on the duration of depressive episodes. *Journal of Abnormal Psychology, 100*(4), 569–582. https://doi.org/10.1037/0021-843x.100.4.569

Nolen-Hoeksema, S. (2000). The role of rumination in depressive disorders and mixed anxiety/depressive symptoms. *Journal of Abnormal Psychology, 109*(3), 504–511. https://doi.org/10.1037/0021-843x.109.3.504

Nolen-Hoeksema, S., & Morrow, J. (1991). A prospective-study of depression and posttraumatic stress symptoms after a natural disaster—The 1989 Loma-Prieta Earthquake. *Journal of Personality and Social Psychology, 61*(1), 115–121. https://doi.org/10.1037/0022-3514.61.1.115

Nolen-Hoeksema, S., & Watkins, E. R. (2011). A heuristic for developing transdiagnostic models of psychopathology: Explaining multifinality and divergent trajectories. *Perspectives on Psychological Science, 6*(6), 589–609. https://doi.org/10.1177/1745691611419672

Nolen-Hoeksema, S., Wisco, B. E., & Lyubomirsky, S. (2008). Rethinking rumination. *Perspectives on Psychological Science, 3*(5), 400–424. https://doi.org/10.1111/j.1745-6924.2008.00088.x

Orbell, S., & Verplanken, B. (2010). The automatic component of habit in health behavior: Habit as cue-contingent automaticity. *Health Psychology, 29*(4), 374–383. https://doi.org/10.1037/a0019596

Pan, A., Sun, Q., Czernichow, S., Kivimaki, M., Okereke, O. I., Lucas, M., et al. (2012). Bidirectional association between depression and obesity in middle-aged and older women. *International Journal of Obesity, 36*(4), 595–602. https://doi.org/10.1038/ijo.2011.111

Paykel, E. S., Scott, J., Teasdale, J. D., Johnson, A. L., Garland, A., Moore, R., et al. (1999). Prevention of relapse in residual depression by cognitive therapy—A controlled trial. *Archives of General Psychiatry, 56*(9), 829–835. https://doi.org/10.1001/archpsyc.56.9.829

Penninx, B. W. (2017). Depression and cardiovascular disease: Epidemiological evidence on their linking mechanisms. *Neuroscience & Biobehavioral Reviews, 74*(Pt B), 277–286. https://doi.org/10.1016/j.neubiorev.2016.07.003

Rahe, C., Unrath, M., & Berger, K. (2014). Dietary patterns and the risk of depression in adults: A systematic review of observational studies. *European Journal of Nutrition, 53*(4), 997–1013. https://doi.org/10.1007/s00394-014-0652-9

Roca, M., Kohls, E., Gili, M., Watkins, E., Owens, M., Hegerl, U., et al. (2016). Prevention of depression through nutritional strategies in high-risk persons: Rationale and design of the MooDFOOD prevention trial. *BMC Psychiatry, 16*, 12. https://doi.org/10.1186/s12888-016-0900-z

Sanchez-Villegas, A., Henriquez-Sanchez, P., Ruiz-Canela, M., Lahortiga, F., Molero, P., Toledo, E., et al. (2015). A longitudinal analysis of diet quality scores and the risk of incident depression in the SUN Project. *BMC Medicine, 13*, 197. https://doi.org/10.1186/s12916-015-0428-y

Sanchez-Villegas, A., & Martinez-Gonzalez, M. A. (2013). Diet, a new target to prevent depression? *BMC Medicine, 11*, 3. https://doi.org/10.1186/1741-7015-11-3

Sanchez-Villegas, A., Martinez-Gonzalez, M. A., Estruch, R., Salas-Salvado, J., Corella, D., Covas, M. I., et al. (2013). Mediterranean dietary pattern and depression: The PREDIMED randomized trial. *BMC Medicine, 11*, 208. https://doi.org/10.1186/1741-7015-11-208

Schmaling, K. B., Dimidjian, S., Katon, W., & Sullivan, M. (2002). Response styles among patients with minor depression and dysthymia in primary care. *Journal of Abnormal Psychology, 111*(2), 350–356. https://doi.org/10.1037//0021-843x.111.2.350

Schwabe, L., & Wolf, O. T. (2011). Stress-induced modulation of instrumental behavior: From goal-directed to habitual control of action. *Behavioural Brain Research, 219*(2), 321–328. https://doi.org/10.1016/j.bbr.2010.12.038

Seldenrijk, A., van Hout, H. P. J., van Marwijk, H. W. J., de Groot, E., Gort, J., Rustemeijer, C., et al. (2011). Depression, anxiety, and arterial stiffness. *Biological Psychiatry, 69*(8), 795–803. https://doi.org/10.1016/j.biopsych.2010.12.034

Spasojevic, J., & Alloy, L. B. (2001). Rumination as a common mechanism relating depressive risk factors to depression. *Emotion (Washington DC), 1*(1), 25–37.

Strine, T. W., Mokdad, A. H., Dube, S. R., Balluz, L. S., Gonzalez, O., Berry, J. T., et al. (2008). The association of depression and anxiety with obesity and unhealthy behaviors among community-dwelling US adults. *General Hospital Psychiatry, 30*(2), 127–137.

Sundararajan, K., Campbell, M. K., Choi, Y. H., & Sarma, S. (2014). The relationship between diet quality and adult obesity: Evidence from Canada. *Journal of the American College of Nutrition, 33*(1), 1–17. https://doi.org/10.1080/07315724.2013.848157

Teismann, T., Von Brachel, R., Hanning, S., Grillenberger, M., Hebermehl, L., Hornstein, I., et al. (2014). A randomized controlled trial on the effectiveness of a rumination-focused group treatment for residual depression. *Psychotherapy Research, 24*(1), 80–90. https://doi.org/10.1080/10503307.2013.821636

Topper, M., Emmelkamp, P. M. G., Watkins, E., & Ehring, T. (2017). Prevention of anxiety disorders and depression by targeting excessive worry and rumination in adolescents and young adults: A randomized controlled trial. *Behaviour Research and Therapy, 90*, 123–136. https://doi.org/10.1016/j.brat.2016.12.015

van Strien, T., Konttinen, H., Homberg, J. R., Engels, R. C. M. E., & Winkens, L. H. H. (2016). Emotional eating as a mediator between depression and weight gain. *Appetite, 100*, 216–224. https://doi.org/10.1016/j.appet.2016.02.034

van't Riet, J., Sijtsema, S. J., Dagevos, H., & De Bruijn, G. J. (2011). The importance of habits in eating behaviour. An overview and recommendations for future research. *Appetite, 57*(3), 585–596. https://doi.org/10.1016/j.appet.2011.07.010

Verplanken, B., Friborg, O., Wang, C. E., Trafimow, D., & Woolf, K. (2007). Mental habits: Metacognitive reflection on negative self-thinking. *Journal of Personality and Social Psychology, 92*(3), 526–541. https://doi.org/10.1037/0022-3514.92.3.526

Verplanken, B., & Wood, W. (2006). Interventions to break and create consumer habits. *Journal of Public Policy & Marketing, 25*(1), 90–103. https://doi.org/10.1509/jppm.25.1.90

Watkins, E. R. (2008). Constructive and unconstructive repetitive thought. *Psychological Bulletin, 134*(2), 163–206. https://doi.org/10.1037/0033-2909.134.2.163

Watkins, E. R. (2016). *Rumination-focused cognitive behavioral therapy for depression*. New York: Guilford Press.

Watkins, E. R., Baeyens, C. B., & Read, R. (2009). Concreteness training reduces dysphoria: Proof-of-principle for repeated cognitive bias modification in depression. *Journal of Abnormal Psychology, 118*(1), 55–64. https://doi.org/10.1037/a0013642

Watkins, E., & Baracaia, S. (2001). Why do people ruminate in dysphoric moods? *Personality and Individual Differences, 30*(5), 723–734. https://doi.org/10.1016/s0191-8869(00)00053-2

Watkins, E., Moberly, N. J., & Moulds, M. L. (2008). Processing mode causally influences emotional reactivity: Distinct effects of abstract versus concrete construal on emotional response. *Emotion, 8*(3), 364–378. https://doi.org/10.1037/1528-3542.8.3.364

Watkins, E., & Moulds, M. (2005). Distinct modes of ruminative self-focus: Impact of abstract versus concrete rumination on problem solving in depression. *Emotion, 5*(3), 319–328. https://doi.org/10.1037/1528-3542.5.3.319

Watkins, E. R., Mullan, E., Wingrove, J., Rimes, K., Steiner, H., Bathurst, N., et al. (2011). Rumination-focused cognitive-behavioural therapy for residual depression: Phase II randomised controlled trial. *The British Journal of Psychiatry, 199*(4), 317–322. https://doi.org/10.1192/bjp.bp.110.090282

Watkins, E. R., & Nolen-Hoeksema, S. (2014). A habit-goal framework of depressive rumination. *Journal of Abnormal Psychology, 123*(1), 24–34. https://doi.org/10.1037/a0035540

Watkins, E. R., Taylor, R. S., Byng, R., Baeyens, C., Read, R., Pearson, K., et al. (2012). Guided self-help concreteness training as an intervention for major depression in primary care: A Phase II randomized controlled trial. *Psychological Medicine, 42*(7), 1359–1371. https://doi.org/10.1017/s0033291711002480

Webb, T. L., & Sheeran, P. (2006). Does changing behavioral intentions engender bahaviour change? A meta-analysis of the experimental evidence. *Psychological Bulletin, 132*(2), 249–268. https://doi.org/10.1037/0033-2909.132.2.249

Wood, W., & Neal, D. T. (2007). A new look at habits and the habit-goal interface. *Psychological Review, 114*(4), 843–863. https://doi.org/10.1037/0033-295x.114.4.843

Chapter 16
The Role of Habits in Maladaptive Behaviour and Therapeutic Interventions

Aukje Verhoeven and Sanne de Wit

A single performance of an unhealthy action, for example drinking a lot of wine during a special dinner, is not a serious issue for one's health aside from a headache the next morning. When this behaviour is consistently repeated, however, it can become problematic. If those few glasses of wine turn into daily overconsumption of alcohol, reaching for a glass of wine becomes increasingly automatic or habitual. For some people this unhealthy habit may persist even when it has far-reaching detrimental consequences for one's health, social relationships, financial security and general well-being. At that point, initially goal-directed behaviour is said to have turned into a compulsive behaviour that jeopardizes health and well-being, and may even become life threatening. Frequent drinking has transitioned from a bad habit into an addiction.

Clearly, maladaptive behaviours with severely detrimental consequences in mental disorders are not the same as so-called bad habits that are bad for one's health but nonetheless allow for adequate daily functioning. However, to some extent similar mechanisms may underlie these different instances of loss of control. Therefore, health- and clinical psychology can potentially benefit from each other's insights and research methods. In this chapter, we compare definitions and measurements of habit used in health- and clinical psychology, and we will discuss the role of habits in therapeutic interventions. Specifically, we focus on a planning strategy (implementation intentions) that has been widely applied in health psychology, and that we argue could be an important component of interventions targeting habitual processes in mental disorders.

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Habits in Health- and Clinical Psychology

Definitions of Habit in Health- and Clinical Psychology

In health psychology, habits are commonly defined as '… *learned sequences of acts that have become automatic responses to specific cues, and are functional in obtaining certain goals or end states*' (Verplanken & Aarts, 1999, p. 104). Automaticity, here, is typically explained in terms of four essential features as proposed by Bargh (1994): (un)intentionality, (un)controllability, (lack of) awareness, and efficiency. The exact definition of habit continues to be a topic of debate (Gardner, Abraham, Lally, & de Bruijn, 2012; Wood & Neal, 2007), but repetition ('learned' behaviours), context stability (presence of 'specific cues'), and automaticity are generally regarded as essential criteria (see also Chaps. 2 and 3 in this volume).

In recent years, clinical psychologists have become increasingly interested in the notion that habits play a role in psychopathologies. Most research in this area has borrowed a definition and operationalisation of habits from animal learning theory. In this theoretical framework, habits are viewed as behaviours that are mediated by stimulus–response associations, stamped in through repetition and reinforced by rewarding consequences or by the termination or prevention of an aversive event (Thorndike, 1911). According to dual-process theories, habits compete with goal-directed processes. Therefore, the degree to which behaviour is habitual is determined by the relative strengths of goal-directed and habitual processes (de Wit & Dickinson, 2009). When goal-directed processes are dominant, behaviours are flexibly guided by current motivation for certain goals. In contrast, when habitual processes become dominant as a consequence of behavioural repetition, behaviour becomes controlled by stimuli independently of the current goal status of the outcome, and consequentially behaviour is no longer immediately sensitive to changes in the desirability of the outcome.

Measurements of Habits in Health and Clinical Psychology

Self-Report Measures

The measurement of habit in health behaviours is largely dominated by self-report measures (although computerised tasks designed to assess underlying cue–response associations are also used, such as the lexical decision task; Neely, 1991). A widely used self-report measure is the frequency*context measure, that is calculated by multiplying self-reported frequency of past behaviour with an indication of the stability of circumstances in which the behaviour is performed (Wood, Witt, & Tam, 2005). Although this measure reliably predicts behaviour (Danner, Aarts, Vries, & de Vries, 2008; Wood et al., 2005), it does not incorporate features of automaticity, such as lack of awareness and uncontrollability. To address this issue, Verplanken and Orbell (2003) developed the *Self-Report Habit Index* (SRHI) that aims to assess the four characteristics of automaticity as outlined by Bargh (1994). Subsequently, Gardner and colleagues have proposed that a subscale of only four items adequately captures automaticity, referred to as the *Self-Report Behavioural Automaticity Index* (SRBAI) (Gardner et al., 2012).

Self-report measures can be conveniently applied to real-life behaviours. This is an important asset in health psychology where studies track changes in habit strength among large and diverse samples to predict everyday behaviour. A point of concern, however, is that measures such as the SRHI ask people to consciously reflect on automaticity, which should be inherently difficult if these behaviours are indeed characterised by a lack of awareness. Nonetheless, there is evidence that such measures can reliably predict behaviour (Verhoeven, Adriaanse, Evers, & de Ridder, 2012; Verplanken, 2006).

Outcome-Devaluation Paradigm

In clinical psychology, inflexible habits have been mostly investigated with the *outcome-devaluation paradigm* (see Habit Research in Action). Animal research using this experimental paradigm has demonstrated that after extensive (but not minimal) training of a lever press response to obtain food, animals are unable to immediately, flexibly adjust their behaviour when the outcome no longer constitutes a goal (i.e. when the outcomes has been devalued through satiation or by conditioning an aversion to the food reward) (Adams, 1982; de Wit & Dickinson, 2009). Only by repeatedly experiencing the no-longer-valuable outcome in relation to the instrumental behaviour, can habits be gradually weakened (i.e. in a reacquisition test).

There are in fact two studies have used the outcome-devaluation paradigm to investigate a health-related habit in humans, namely in the food domain. In one of these studies, the outcome devaluation paradigm was translated to an applied context (Neal, Wood, Wu, & Kurlander, 2011). Participants were offered popcorn to eat in the cinema, which was either fresh or stale. The experimenters found that individuals who did not have a long history of consuming popcorn in the cinema flexibly adapted their behaviour to the desirability of the outcome: they consumed more of the fresh than of the stale popcorn. In contrast, participants with a strong habit ate just as much of the fresh as of the stale popcorn, suggesting that the behaviour of eating popcorn in the cinema had become inflexible as a result of behavioural repetition. Importantly, in a (non-habitual) meeting room that had not yet been directly associated with the act of eating popcorn, participants with strong (cinema-popcorn) habits did consume less stale than fresh popcorn. This finding underscores the importance of stimulus–response links in habitual behaviour.

The second study to investigate food-related habits in humans was conducted in the lab with a computerised task (Tricomi, Balleine, & O'Doherty, 2009). Here, participants learned that two distinct stimuli (pictures of fractals) signalled which of two responses (left or right key presses) would lead to a certain snack reward (Smarties or Frito's). After the initial learning phase, participants were sated on one of the snacks in order to devalue that outcome. In the following extinction choice test, participants could again respond to the fractal stimuli. As you might expect, after short training, participants pressed less after seeing the stimulus that was associated with the devalued outcome. Thus, if participants were sated on Frito's, they immediately (without receiving further feedback) reduced key pressing upon presentation of the stimulus associated with this outcome. This goal-directed control was, however, only observed after brief training. After long training during multiple days, participants pressed equally often in the presence of the two stimuli. They thus perseverated in responding towards the devalued outcome, suggesting that behavioural repetition had led to the formation of stimulus-driven habits. However, we should point out that a recent attempt to replicate those findings failed, which casts doubt on the robustness of the original demonstration (de Wit et al., 2018). Furthermore, extensive training on two related outcome-devaluation paradigms also failed to establish habitual performance (de Wit et al., 2018). It appears to be challenging, therefore, to demonstrate habits as a function of overtraining in humans in the lab.

Another approach to the study of habits has been to investigate individual differences in behavioural flexibility. The underlying idea is that these paradigms can reveal that some people are *generally* more prone to forming habits than others, either as a consequence of forming strong stimulus–response habits fast and/or due to impaired goal-directed control (de Wit & Dickinson, 2009). Importantly, according to the dual-process perspective, such *habit propensity* can already become apparent after minimal training as habits are gradually formed from the outset of training. One of the outcome devaluation paradigms most commonly employed in this line of research, is the computerised slips-of-action task. In this task, participants initially learn that discriminative cues (pictures on the screen) signal that certain responses (key presses) lead to rewarding pictures, but are subsequently instructed that some of the pictures now lead to deduction of points ('instructed devaluation'). In the test phase, the discriminative stimuli are again presented in quick succession, and participants' ability to refrain from responding to stimuli signalling the availability of devalued outcomes while continuing to collect still-valuable outcomes is used as a measure of habit propensity (see the 'Habit Research in Action' box). With this paradigm, individual differences in habit propensity have been linked to white-matter pathways between cortical and striatal brain areas that are thought to play an important role in goal-directed and habitual control (de Wit et al., 2012). Furthermore, as will be reviewed in the next section, this approach has been used to provide evidence for habit propensity in psychopathologies, as for example addiction and obsessive-compulsive disorder (Ersche et al., 2016; Gillan et al., 2011).

Conclusions

In summary, different measures have been used to study the role of habits in health- and pathological behaviours. In health psychology, habit strength is typically measured with self-report measures (e.g. SRHI and SRBAI). Using these questionnaires, evidence has been provided for the importance of habits in numerous behaviours, including unhealthy behaviours such as smoking (Orbell & Verplanken, 2010), drinking alcohol (Norman, 2011), and unhealthy dietary behaviours (van't Riet, Sijtsema, Dagevos, & De Bruijn, 2011; Verhoeven et al., 2012; Verplanken, 2006). Importantly, research with these measures demonstrates that self-reported habit strength is oftentimes more predictive of behaviour than explicit goal intentions (De Bruijn, 2010; Verplanken & Aarts, 1999; Verplanken & Wood, 2006), which relates to Bargh's automaticity factor 'unintentionality'.

In the present section we also discussed outcome-devaluation paradigms that have been developed by experimental psychologists to put behavioural insensitivity to one's current goals to the test. It could be argued that these outcome-devaluation paradigms provide an experimental measure of unintentionality and uncontrollability. However, in clinical psychology, these paradigms have been mostly used in the lab with arbitrary stimuli, responses and rewards to investigate general habit propensity in psychopathologies. A promising future approach is to translate this paradigm to an applied setting to investigate more directly the role of habits in everyday behaviours that are embedded in complex environments (for related studies, see Linnebank, Kindt, & de Wit, 2018; Neal et al., 2011). However, assessing experimentally whether habits contribute to clinically relevant behaviours is more challenging to accomplish both from a practical and ethical point of view. Another promising approach, therefore, is to use the SRHI to measure the subjective uncontrollability of maladaptive behaviours that are part of the symptomatology of mental disorders (i.e. Behaviour X is something… 'that would require effort not to do it' and 'I would find hard not to do') in order to gain insight into the role of habits in psychopathologies and treatment thereof (for a related endeavour in the context of depression, see Chap. 15).

Habits in Mental Disorders

In recent years clinical psychologists have become increasingly interested in the notion that habits play a role in psychopathologies. Most mental disorders are characterised by maladaptive behaviours that are frequently performed in the presence of certain stable (external and internal) triggers. The longer disorders are left untreated, the more challenging it is to change these behaviours, in line with the idea that deeply ingrained habits have formed. Furthermore, the role of habits may not be confined to motor behaviours, but may also concern attentional processes (Luque et al., 2017) and recurrent maladaptive thought patterns (see Chap. 15). We argue, therefore, that habits play an important role in the development of mental disorders and constitute an important target for treatment.

Habits may play a particularly pivotal role in the development of psychopathologies characterised by compulsive behaviours that persist despite awareness of detrimental consequences regarding health, occupational and social functioning (Robbins, Gillan, Smith, de Wit, & Ersche, 2012). Indirect support for this possibility comes from studies implicating dysfunctional corticostriatal networks in compulsive behaviour (e.g. obsessive-compulsive disorder and addiction), which have also been shown to play a role in the balance between goal-directed and habitual control (Robbins et al., 2012). Indeed, the role of habits has received most attention in research into drug addiction, using both animal and human models (Everitt & Robbins, 2015; Tiffany, 1990). In animals, it has been shown that repeated drug seeking renders the behaviour insensitive to outcome devaluation (e.g. Corbit, Nie, & Janak, 2012), suggesting that repetition fosters the transition from goal-directed drug seeking to drug habits. Furthermore, habit formation has been shown to be accelerated with drug rewards relative to natural (food) rewards (Dickinson, Wood, & Smith, 2002; Miles, Everitt, & Dickinson, 2003), which may be due to strong stimulus–response reinforcement by drugs. A long history of drug seeking has also been shown to lead to drug seeking that persists in the face of adverse consequences, such as foot shock in (a subset of) animals (Deroche-Gamonet, 2004). This demonstration provides direct support for the uncontrollability of extensively repeated drug seeking. Finally, repeated consumption of alcohol or amphetamine leads to enhanced *general* habit propensity, as reflected in accelerated habit formation in the context of an unrelated food reward (Corbit et al., 2012; Nelson & Killcross, 2006). Studies in patients have provided convergent evidence for a general tendency to rely on habits in alcohol and cocaine abuse, as reflected in impaired performance on the slips-of-action paradigm (see the 'Habit Research in Action' box) and a related task (Ersche et al., 2016; Sjoerds et al., 2013) that used rewards unrelated to addiction (pictures that were worth credits).

So far, the evidence reviewed points to a central role of habits in addiction, but we should point out that studies in smokers by Hogarth and colleagues have failed to provide converging evidence (e.g. Hogarth & Chase, 2011; see Chap. 18 for an elaborate discussion of the view that habits do *not* play an important role in addiction). However, they adopted an outcome-devaluation paradigm with a simple concurrent choice test, which may not be optimally sensitive to detect habits in humans due to the absence of trigger cues. Another recent study that casts doubt on the habit theory of addiction suggests that habit learning may not be necessary for the development of (cocaine) addiction in animals (Singer, Fadanelli, Kawa, & Robinson, 2017). To conclude, there is a continuing debate about the role of habits in addiction. As reviewed here, there is substantial evidence to support the view that habits play a role in the loss of control over drug seeking, but the question certainly remains whether habits are necessary for the development of compulsive behaviour, and to what degree impaired performance in outcome-devaluation studies is due to strong habitual processes or to impaired goal-directed and related executive control functions (Watson & de Wit, 2018).

Evidence for habit propensity has also been found in other compulsive disorders like Tourette's syndrome (Delorme et al., 2016) and obsessive-compulsive disorder (Gillan et al., 2011, 2014), in which patients feel compelled to perform repetitive behaviours such as ritualistic checking and washing that severely impair daily functioning. On the other hand, the notion that enhanced habit propensity constitutes an important trans-diagnostic trait in conditions characterised by compulsivity (Robbins et al., 2012) has not received support from a recent study into habit propensity in anorexia patients (Godier et al., 2016). Furthermore, in two other studies, obese individuals performed at the same level as healthy-weight controls on the slips-of-action task (Dietrich, De Wit, & Horstmann, 2016; Watson, Wiers, Hommel, Gerdes, & de Wit, 2017). However, there is evidence that obese individuals with binge eating disorder do show impaired model-based decision-making (which may be similar to goal-directed control) (Voon et al., 2015). Also, animal research suggests that a binge-like diet can enhance habit propensity (Parkes, Furlong, Black, & Balleine, 2017).

On the other hand, we should point out that a general tendency to rely on habits has also been demonstrated in disorders in which compulsivity is not a central characteristic, as for example, schizophrenia (Morris, Quail, Griffiths, Green, & Balleine, 2015), social anxiety disorder (Alvares, Balleine, & Guastella, 2014), and Parkinson's disease (de Wit, Barker, Dickinson, & Cools, 2011). A possible explanation is offered by the dual-process perspective, according to which impaired goal-directed control can lead to reliance on inflexible habits, with increasing evidence suggesting that many mental disorders are characterized by impaired executive control functions such as working memory, cognitive flexibility, and inhibitory control (Fineberg et al., 2010; Robbins et al., 2012). In many situations, executive functions are likely to play a pivotal role in goal-directed control, and impaired executive functioning may therefore contribute to the challenge of curbing maladaptive habits in mental disorders. Another common factor across many mental disorders is stress, which has also been shown to lead to increased reliance on habits (Schwabe & Wolf, 2009).

Targeting Habits in Therapeutic Interventions

Techniques that target habits to promote enduring behavioural change may be especially relevant for clinical populations that are characterized by high levels of habit propensity (Delorme et al., 2016; Gillan et al., 2011; Sjoerds et al., 2013), but should be considered for mental disorders generally, as reducing undesirable behaviours and/or instilling adaptive behaviours is a common treatment goal. The most obvious way to support the suppression of maladaptive stimulus–response habits is to avoid risk situations (e.g. a place where one has regularly used drugs in the past) or remove trigger stimuli (e.g. remove unhealthy food products from one's home). Indeed, in their 'habit discontinuity hypothesis', Verplanken and colleagues have referred to instances of context change as windows of opportunity for behavioural change (Verplanken, Walker, Davis, & Jurasek, 2008; see Chap. 11 in this book). However, changing one's external environment is not always practically feasible, and may be especially challenging when triggers are internal (e.g. stress or anxious thoughts). Therefore, additional strategies are necessary, especially when attempting to change deeply ingrained behaviours.

A promising behaviour change strategy in health psychology concerns the use of *implementation intentions* (Gollwitzer, 1999), which are specific if-then plans that link a specific context to a desirable instrumental response: '*If I encounter stimulus S, then I will perform instrumental response R!*'. Importantly, these have been found to be more effective than goal intentions that merely specify personal goals ('*I intend to reach goal X*'). The effectiveness of these if-then plans has been proposed to depend on two underlying mechanisms (Webb & Sheeran, 2007): Firstly, the specified situation becomes highly accessible and is therefore more easily detected as a good opportunity to act. Secondly, the desirable response is triggered in a relatively automated fashion when the specific situation is encountered. Therefore, implementation intentions are thought to delegate control to situational stimuli that can trigger behaviour in an automatic and efficient fashion (Gollwitzer, 1999; Webb & Sheeran, 2007).

Changing Maladaptive Behaviours Through Implementation Intentions

While there has been limited research into implementation intentions in a clinical context, if-then plans have been extensively studied in relation to health-related behaviours. For example, it has been demonstrated that implementation intentions are very effective for promoting healthy eating behaviours, and can also (albeit to a lesser extent) reduce existing unhealthy eating habits (Adriaanse, Vinkers, De Ridder, Hox, & De Wit, 2011; see also Chap. 10 in this volume). Moreover, research has demonstrated that implementation intentions support weight loss among people with strong dieting goals (Veling, van Koningsbruggen, Aarts, & Stroebe, 2014). Finally, Luszczynska, Sobczyk, and Abraham (2007) demonstrated that among an overweight and obese sample, adding implementation intentions to a weight watchers program promoted additional weight loss.

Implementation intentions have also been investigated in the context of addictive substances (in sub-clinical samples). For example, implementation intentions to quit smoking (e.g. '*if I am tempted to smoke at a bar or pub having a drink, then I will think about something else*') led to increased quit rates and decreased self-reported nicotine dependence relative to goal intentions (Armitage, 2008). A more recent study showed that beneficial effects of implementation intentions on attempts to stop or reduce smoking were mediated by changes in self-reported automaticity of smoking, suggesting that the effectiveness of this intervention does indeed depend on its ability to reduce the underlying habit (Armitage, 2016). However, deeply ingrained smoking behaviours in people with a long history of smoking addiction are challenging to curb, even with implementation intentions (Webb, Sheeran, & Luszczynska, 2009).

Implementation intentions have also been applied to drinking, for example to encourage a third-person perspective on binge drinking and thereby reduce this behaviour ('*If I am at the limit for a binge, then I ignore the urge to drink and will look at the situation as if I were someone else!*') (Rivis & Sheeran, 2013). Two other studies provided additional support that implementation intentions are more effective than goal intentions in reducing drinking (e.g. '*If I am in a bar/pub drinking with my friends and I am likely to drink over the daily safe limits for alcohol, then I will opt for a soft drink instead of an alcoholic drink to keep within the recommended safe limits*') (Hagger et al., 2012; Hagger, Lonsdale, & Chatzisarantis, 2012). In conclusion, implementation intentions are effective in reducing health-harming behaviours such as unhealthy eating, smoking, and alcohol consumption.

Research into Implementation Intentions in Clinical Samples

Implementation intentions have already been found to be effective among clinical populations. Typically, the intentions were not directly targeted at reducing behaviours that are part of the symptomatology of these disorders, but there are some exceptions. In a recent study (O'Connor et al., 2017), treatment as usual of patients who had presented with a self-harm episode with evidence for a suicidal attempt was supplemented with an implementation intention-based intervention (e.g. '*If I am tempted to self-harm when I want to get relief from a terrible state of mind, then I will seek someone who listens when I need to talk about self-harm*'). This brief planning intervention reduced self-harm over and above treatment as usual in a subgroup of people who completed it and who had previously been admitted to hospital with self-harm. These preliminary findings are promising for the use of this planning strategy to reduce behaviours with far-reaching adverse consequences.

Implementation intentions have also been used to increase adaptive behaviours in clinical populations. For example, psychotherapy attendance has been successfully increased (e.g. '*As soon as I feel concerned about attending my appointment, I will ignore that feeling and tell myself this is perfectly understandable!*') (Sheeran, Aubrey, & Kellett, 2007). In another study, behavioural activation in depressed individuals (i.e. increasing social/physical activities) was enhanced by an intervention incorporating implementation intentions to overcome the most important obstacle for personal activity goals (Fritzsche, Schlier, Oettingen, & Lincoln, 2016; but see, Pomp, Fleig, Schwarzer, & Lippke, 2013). Similarly, implementation intentions led to increased participation in a physical activity intervention in patients diagnosed with schizophrenia (Sailer et al., 2015). Another adaptive behaviour that can be promoted by implementation intentions is relaxation under stressful circumstances in people suffering from anxiety (e.g. '*If I feel under pressure, then I will immediately use my breathing tactic to relax*') (Shah, Hunt, Webb, & Thompson, 2014; Varley, Webb, & Sheeran, 2011; Webb, Ononaiye, Sheeran, Reidy, & Lavda, 2010).

A meta-analysis incorporating the above-mentioned research and other studies in a clinical context indicated that implementation intentions were indeed effective among clinical samples to support them in attaining their goals (Toli, Webb, & Hardy, 2016). The effect observed in this meta-analysis was large ($d_+ = 0.99$) in comparison to meta-analyses among non-clinical populations (Adriaanse, Vinkers, et al., 2011; Bélanger-Gravel, Godin, & Amireault, 2013; Gollwitzer & Sheeran, 2006). Together, this research suggests that clinical populations can benefit from if-then plans, but the extent to which deeply ingrained behaviours that are central to disorders (e.g. drinking in alcoholics) are malleable targets for this planning technique should be further investigated.

(Disorder-Related) Indicators for Effectiveness of Implementation Intentions

Certain personality traits have been found to moderate the effectiveness of implementation intentions. A character trait that negatively predicts their effectiveness is *socially prescribed perfectionism*, characterised by a preoccupation to reach ideals and standards set by significant others. Formulating implementation intentions to achieve New Year's resolutions actually appears to backfire for individuals high in socially described perfectionism (Powers, Koestner, & Topciu, 2005). These findings warrant cautiousness in applying this planning technique to mental disorders that have been linked to this trait, such as depression, anxiety, and obsessive-compulsive disorder (Powers et al., 2005). Another personality trait that is negatively related with the effectiveness of implementation intentions is the impulsivity dimension *urgency* (Churchill & Jessop, 2010, 2011), characterised by the tendency to act impulsively under circumstances when negative affect is experienced. Churchill and Jessop (2011) found that implementation intentions were not effective in promoting a healthy diet among individuals scoring high on this dimension.

On the other hand, people with relatively *low executive functioning,* as assessed with a Go/No-Go task, benefited relatively strongly from implementation intentions to increase levels of physical activity (Hall, Zehr, Ng, & Zanna, 2012). Hence, if-then plans may be particularly beneficial for mental disorders that are characterised by low levels of executive functioning. Relatedly, implementation intentions can also be used to boost performance on executive functioning tasks. In children with ADHD, implementation intentions improved performance on a Go/No-Go task measure of response inhibition (i.e. '*if I hear a sound, then I will not press any key*') (Gawrilow & Gollwitzer, 2008; Paul-Jordanov, Bechtold, & Gawrilow, 2010). Adults diagnosed with schizophrenia (Brandstätter, Lengfelder, & Gollwitzer, 2001) and patients with frontal lesions (Lengfelder & Gollwitzer, 2001) also benefitted from implementation intentions when performing a Go/No-Go task.

Incorporating Implementation Intentions into Cognitive-Behavioural Treatment (CBT)

CBT encourages the development of adaptive routines through practice. On the basis of the research reviewed in this chapter, we propose that CBT could benefit from incorporating implementation intentions to accelerate the formation of adaptive habits. In clinical settings, therapists have the advantage that they can support their patients in formulating effective if-then plans during therapeutic sessions (Hagger & Luszczynska, 2014). Alternatively, in some cases a more cost-effective way to guide effective implementation intention formation could be to use a *Volitional Help Sheet* in which patients could select critical situations from a pre-specified list and link them to desirable responses (Armitage, 2008; O'Connor et al., 2017), which could be incorporated into self-help or E-health interventions. In any case, when it comes to forming good plans and using related techniques to support planned behaviour, clinical practice could potentially benefit from insights that have been gained in health psychology. In this section, we discuss some of the most important insights and the extent to which these can be (or are already) incorporated in clinical treatments (for a more detailed discussion of guidelines for implementation intentions, see also Chap. 10 in this volume). We should point out that there have already been promising endeavours to incorporate implementation intentions into cognitive-behavioural therapy in depression. Specifically, implementation intentions directly targeted at reducing rumination have been incorporated into a treatment package for rumination-focused treatment (Watkins et al., 2011) and concreteness training (Watkins et al., 2012). However, for an elaborate discussion of implementation intentions in depression we refer the reader to Chap. 15 in this volume.

Although if-then plans are usually not part of the treatment of mental disorders, it is common for the therapist to analyse the problem behaviour together with the patient at the start of treatment. To illustrate, in cognitive-behavioural therapy of drug abuse, patients are asked to identify circumstances, thoughts, and feelings leading up to and following drug use. Such a *functional analysis* specifies antecedents, behaviours, and consequences, and is used to better understand what triggers and maintains the maladaptive behaviour which can inform treatment goals and attempts to replace drug habits with more positive, rewarding activities by linking these with the original triggers. This replacement approach is in line with the idea from the implementation intention literature that simply trying to suppress the habitual response leads to ironic processes (Adriaanse, van Oosten, de Ridder, de Wit, & Evers, 2011), such that the unwanted behaviour actually increases (e.g. '*if I am at a bar, I will not drink alcohol*'). Implementation intentions as part of CBT for addiction could also reduce the need for extensive training of coping skills that can be incorporated into the daily routines of patients, and could support effective dealing with craving and relapse (e.g. '*if I relapse, I will call a friend to ask for support*'). We should point out that the notion of replacing unwanted habits with more desirable or neutral habits (as opposed to simply suppressing the unwanted behaviour) is also part of many other CBT treatments, as for example Habit Reversal Therapy that is used to reduce repetitive, compulsive behaviours, such as tics. Here, patients are trained to replace the tic (in response to a certain trigger) with a neutral behaviour that is incompatible at the motor level (e.g. pursing one's lips instead of sticking out one's tongue) (Bate, Malouff, Thorsteinsson, & Bhullar, 2011; see also Chap. 9 in this volume).

In contrast to implementation intention interventions, in CBT patients are usually not explicitly asked to rehearse the link between the if- and then-parts of the plan in order to strengthen the association between the cue and the desirable response (Hagger et al., 2016), or to mentally imagine enacting the plan (Knäuper et al., 2011; Knäuper, Roseman, Johnson, & Krantz, 2009). Here, CBT may benefit from knowledge from the implementation intention literature demonstrating the effectiveness of mentally linking triggers with behaviours to promote goal achievement. However, how implementation intentions can be formulated most effectively is still not fully understood. Many researchers in this field have suggested that implementation intentions benefit from its specific 'if-then' structure, but only two studies explicitly investigated and supported the importance of this structure (Chapman, Armitage, & Norman, 2009; Oettingen, Hönig, & Gollwitzer, 2000).

There are different techniques that can be used to boost the success of implementation intentions. First of all, research into implementation intentions suggests that high motivation to obtaining one's goal is a key pre-requisite for behavioural change and the effectiveness of planning strategies (Gollwitzer, 1993; Sheeran, Webb, & Gollwitzer, 2005). In line with this notion, motivational interviewing techniques are an integral part of many clinical treatments to enhance patients' motivation (Rubak, Sandbaek, Lauritzen, & Christensen, 2005; Treasure, 2004). Furthermore, to support the formation of an effective plan, health psychologists have applied strategies to increase participants' insight into the triggers of their unwanted behaviour, such as adding *mental contrasting* to support the identification of obstacles (Fritzsche et al., 2016; Oettingen, 2012; Sailer et al., 2015, see Chap. 10 for further details), or keeping a *cue monitoring diary* to gain insight into triggers (Verhoeven, Adriaanse, de Vet, Fennis, & de Ridder, 2014). Registration of the problem behaviour and (external and internal) triggers is in fact already common in CBT, for example via a self-monitoring diary to support a functional analysis.

Another insight derived from health psychology is that only one implementation intention should be formulated at a time, as formulating multiple plans jeopardizes the effectiveness of this strategy (Dalton & Spiller, 2012; Verhoeven, Adriaanse, Ridder, Vet, & Fennis, 2013). Translating this to clinical practice means that therapists should work at behavioural treatment goals sequentially as opposed to simultaneously. This sequential approach is already an established part of certain clinical treatments. For example, in Exposure Response Prevention applied to obsessive-compulsive disorder (Abramowitz, 1996), patients are exposed to stimuli that trigger an obsession and/or compulsion and they practice suppressing compulsive behaviours, starting with the least strong triggers.

Finally, another potentially promising avenue could be to combine add-on treatments that target habitual processes with implementation intentions. Specifically, Cognitive Bias Modification (CBM) aims to change automatic biases, by retraining, for example, an attentional or an approach bias towards drug-associated stimuli (Schoenmakers et al., 2010; Wiers, Eberl, Rinck, Becker, & Lindenmeyer, 2011). The effectiveness of these treatments may be boosted by furnishing them with implementation intentions (e.g. '*If my attention is grabbed by alcohol products in the supermarket, then I direct my attention towards soft drinks*').

Conclusion

In this chapter we have argued that habits not only contribute to inflexibility of health-related behaviours that have been extensively repeated in stable contexts, but also to maladaptive behaviours in mental disorders, particularly disorders characterised by compulsivity and by habit propensity due to aberrantly strong habitual control and/or weak goal-directed control. Further research is needed to determine to what extent different habit measures in health- and clinical psychology (self-report measures and outcome-devaluation paradigms, respectively) measure the same construct and can be usefully applied to the other field.

Given the evidence from health psychology for the importance of effective planning, cognitive-behavioural therapies could be furnished with implementation intentions to reduce the need for extensive practice to form new adaptive routines. This planning technique, and related techniques that boost its effectiveness, may be particularly beneficial in mental disorders in which reduced goal-directed and executive functioning and a tendency to rely on habits reduce the effectiveness of standard treatment (Alvares et al., 2014). Insights from health psychology may to some extent guide how implementation intentions can be effectively incorporated into clinical treatments. In fact, although a different terminology is used, certain components of CBT already mimic processes that have been shown to increase implementation intentions' effectiveness. However, the effectiveness of behavioural planning as part of CBT is usually not investigated in isolation. *Component analyses* of cognitive-behavioural therapies should investigate how planning techniques can be optimised for treating mental disorders. Conversely, interventions in health psychology could benefit from a synergistic approach, in which implementation intentions are combined with other strategies to support goal pursuit (e.g.Hagger, Lonsdale, et al., 2012; Milne, Orbell, & Sheeran, 2002). Finally, the question remains whether implementation intentions are sufficiently powerful to reduce maladaptive or compulsive behaviours that are central to mental disorders (e.g. O'Connor et al., 2017; see also Chap. 15 in this volume). Further research is required, therefore, to determine whether implementation intentions as an integral part of CBT can support the replacement of maladaptive behaviours with novel adaptive habits.

Habit Research in Action

Animal research: outcome-devaluation paradigm

This paradigm consists of three consecutive stages: instrumental training, outcome devaluation, and an extinction test. In the first experimental demonstration of overtrained habits in animals, Adams (1982) trained hungry rats to lever press for food pellets. Following this initial learning phase, rats were removed from the Skinnerbox, and for half of the animals an aversion was conditioned to the food pellets by pairing it with lithium chloride-induced nausea. Subsequently, rats were returned to the Skinnerboxes, where they could once again press the lever. During this test, the rats pressed less if the outcome had been devalued. Importantly, the test was conducted in extinction, which means that the outcomes were no longer presented. As a result, the devaluation effect must have been mediated by knowledge of the response-outcome contingency as well as evaluation of the current value of the anticipated pellet outcome. In other words, performance was goal-directed. However, this was the case only in animals that had received minimal training (100 lever presses). Animals that had been trained extensively (500 presses) continued to respond for the devalued outcome, suggesting that behaviour had transitioned into a habit.

Human research: The slips-of-action paradigm

The slips-of-action paradigm is a computerized outcome-devaluation task that is used to investigate 'habit propensity' in humans (e.g. de Wit et al., 2012). For the participants, the goal is to collect rewarding outcomes that are worth points and/or money. During the training phase, participants learn that after a certain stimulus (e.g. grapes) a specific response should be performed (e.g., pressing a left key) in order to gain a rewarding outcome (e.g. a pineapple) (see Fig. 16.1a, b). In this way, participants learn different stimulus-response-outcome contingencies. Initially, during the training phase, all available outcomes are valuable. However, in a subsequent test phase, some of these outcomes are devalued, meaning that these will lead to subtraction of points (1C). Hence, participants should selectively press upon appearance of stimuli that are associated with still-valuable outcomes and suppress responses for devalued outcomes (1D). The extent to which they are able to do this is thought to reflect relative goal-directed and habitual control. The test is conducted in nominal extinction, and therefore in the absence of feedback.

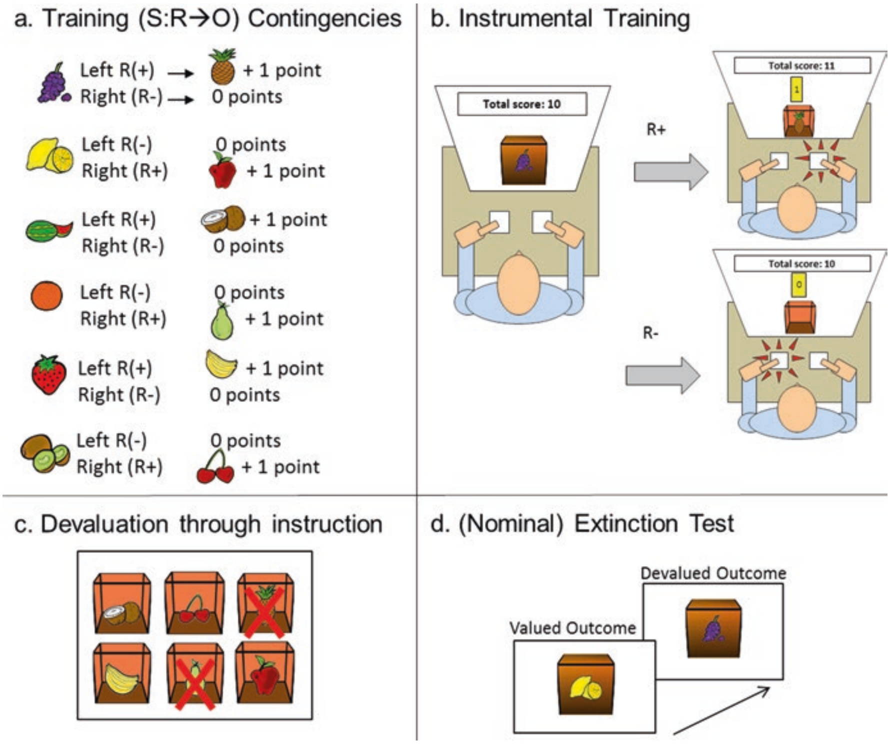

Fig. 16.1 Illustration of the slips-of-action task. (**a**) Stimulus: response-outcome contingencies; (**b**) example of instrumental training trials (**c**) example of devaluation instruction screen; (**d**) example of test trials

References

Abramowitz, J. S. (1996). Variants of exposure and response prevention in the treatment of obsessive-compulsive disorder: A meta-analysis. *Behavior Therapy, 27*(4), 583–600.

Adams, C. D. (1982). Variations in the sensitivity of instrumental responding to reinforcer devaluation. *The Quarterly Journal of Experimental Psychology, 34*(2), 77–98.

Adriaanse, M. A., van Oosten, J. M., de Ridder, D. T., de Wit, J. B., & Evers, C. (2011). Planning what not to eat: Ironic effects of implementation intentions negating unhealthy habits. *Personality & Social Psychology Bulletin, 37*(1), 69–81.

Adriaanse, M. A., Vinkers, C. D., De Ridder, D. T., Hox, J. J., & De Wit, J. B. (2011). Do implementation intentions help to eat a healthy diet? A systematic review and meta-analysis of the empirical evidence. *Appetite, 56*(1), 183–193.

Alvares, G. A., Balleine, B. W., & Guastella, A. J. (2014). Impairments in goal-directed actions predict treatment response to cognitive-behavioral therapy in social anxiety disorder. *PLoS One, 9*(4), e94778.

Armitage, C. J. (2008). A volitional help sheet to encourage smoking cessation: A randomized exploratory trial. *Health Psychology, 27*(5), 557–566.

Armitage, C. J. (2016). Evidence that implementation intentions can overcome the effects of smoking habits. *Health Psychology, 35*(9), 935–943.

Bargh, J. (1994). The four horsemen of automaticity: Intention, awareness, efficiency, and control as separate issues. In R. Wyer & T. Srull (Eds.), *Handbook of social cognition*. Lawrence Erlbaum.

Bate, K. S., Malouff, J. M., Thorsteinsson, E. T., & Bhullar, N. (2011). The efficacy of habit reversal therapy for tics, habit disorders, and stuttering: A meta-analytic review. *Clinical Psychology Review, 31*(5), 865–871.

Bélanger-Gravel, A., Godin, G., & Amireault, S. (2013). A meta-analytic review of the effect of implementation intentions on physical activity. *Health Psychology Review, 7*(1), 23–54.

Brandstätter, V., Lengfelder, A., & Gollwitzer, P. M. (2001). Implementation intentions and efficient action initiation. *Journal of Personality and Social Psychology, 81*(5), 946–960.

Chapman, J., Armitage, C. J., & Norman, P. (2009). Comparing implementation intention interventions in relation to young adults' intake of fruit and vegetables. *Psychology and Health, 24*(3), 317–332.

Churchill, S., & Jessop, D. (2010). Spontaneous implementation intentions and impulsivity: Can impulsivity moderate the effectiveness of planning strategies? *British Journal of Health Psychology, 15*(3), 529–541.

Churchill, S., & Jessop, D. C. (2011). Too impulsive for implementation intentions? Evidence that impulsivity moderates the effectiveness of an implementation intention intervention. *Psychology and Health, 26*(5), 517–530.

Corbit, L. H., Nie, H., & Janak, P. H. (2012). Habitual alcohol seeking: Time course and the contribution of subregions of the dorsal striatum. *Biological Psychiatry, 72*(5), 389–395.

de Wit, S., Barker, R. A., Dickinson, A., & Cools, R. (2011). Habitual versus goal-directed action control in Parkinson disease. *Journal of Cognitive Neuroscience, 23*(5), 1218–1229.

de Wit, S., & Dickinson, A. (2009). Associative theories of goal-directed behaviour: A case for animal–human translational models. *Psychological Research, 73*(4), 463–476.

de Wit, S., Kindt, M., Knot, S. L., Verhoeven, A. A. C., Robbins, T. W., Gasull-Camos, J., et al. (2018). Shifting the balance between goals and habits: Five failures in experimental habit induction. *Journal of Experimental Psychology – General, 147*(7), 1043–1065.

de Wit, S., Watson, P., Harsay, H. A., Cohen, M. X., van de Vijver, I., & Ridderinkhof, K. R. (2012). Corticostriatal connectivity underlies individual differences in the balance between habitual and goal-directed action control. *The Journal of Neuroscience, 32*(35), 12066–12075.

Dalton, A. N., & Spiller, S. A. (2012). Too much of a good thing: The benefits of implementation intentions depend on the number of goals. *Journal of Consumer Research, 39*(3), 600–614.

Danner, U. N., Aarts, H., Vries, N. K., & de Vries, N. K. (2008). Habit vs. intention in the prediction of future behaviour: The role of frequency, context stability and mental accessibility of past behaviour. *The British Journal of Social Psychology, 47*(2), 245–265.

De Bruijn, G. (2010). Understanding college students' fruit consumption. Integrating habit strength in the theory of planned behaviour. *Appetite, 54*(1), 16–22.

Delorme, C., Salvador, A., Voon, V., Roze, E., Vidailhet, M., Hartmann, A., et al. (2016). Illusion of agency in patients with gilles de la tourette syndrome. *Cortex, 77*, 132–140.

Deroche-Gamonet, V. (2004). Evidence for addiction-like behavior in the rat. *Science, 305*(5686), 1014–1017.

Dickinson, A., Wood, N., & Smith, J. W. (2002). Alcohol seeking by rats: Action or habit? *The Quarterly Journal of Experimental Psychology, 55*(4), 331–348.

Dietrich, A., De Wit, S., & Horstmann, A. (2016). General habit propensity relates to the sensation seeking subdomain of impulsivity but not obesity. *Frontiers in Behavioral Neuroscience, 10*(213), 1–14.

Ersche, K. D., Gillan, C. M., Jones, P. S., Williams, G. B., Ward, L. H. E., Luijten, M., et al. (2016). Carrots and sticks fail to change behavior in cocaine addiction. *Science (New York, N.Y.), 352*(6292), 1468–1471.

Everitt, B. J., & Robbins, T. W. (2015). Drug addiction: Updating actions to habits to compulsions ten years on. *Annual Review of Psychology, 67*, 23–50.

Fineberg, N. A., Potenza, M. N., Chamberlain, S. R., Berlin, H. A., Menzies, L., Bechara, A., et al. (2010). Probing compulsive and impulsive behaviors, from animal models to endophenotypes: A narrative review. *Neuropsychopharmacology, 35*(3), 591–604.

Fritzsche, A., Schlier, B., Oettingen, G., & Lincoln, T. M. (2016). Mental contrasting with implementation intentions increases goal-attainment in individuals with mild to moderate depression. *Cognitive Therapy and Research, 40*(4), 557–564.

Gardner, B., Abraham, C., Lally, P., & de Bruijn, G. (2012). Towards parsimony in habit measurement: Testing the convergent and predictive validity of an automaticity subscale of the self-report habit index. *International Journal of Behavioral Nutrition and Physical Activity, 9*(1), 1.

Gawrilow, C., & Gollwitzer, P. M. (2008). Implementation intentions facilitate response inhibition in children with ADHD. *Cognitive Therapy and Research, 32*(2), 261–280.

Gillan, C. M., Morein-Zamir, S., Urcelay, G. P., Sule, A., Voon, V., Apergis-Schoute, A. M., et al. (2014). Enhanced avoidance habits in obsessive-compulsive disorder. *Biological Psychiatry, 75*(8), 631–638.

Gillan, C. M., Papmeyer, M., Morein-Zamir, S., Sahakian, B. J., Fineberg, N. A., Robbins, T. W., et al. (2011). Disruption in the balance between goal-directed behavior and habit learning in obsessive-compulsive disorder. *American Journal of Psychiatry, 168*(7), 718–726.

Godier, L. R., de Wit, S., Pinto, A., Steinglass, J. E., Greene, A. L., Scaife, J., et al. (2016). An investigation of habit learning in Anorexia Nervosa. *Psychiatry Research, 244*, 214–222.

Gollwitzer, P. M. (1993). Goal achievement: The role of intentions. *European review of social psychology, 4*(1), 141–185.

Gollwitzer, P. M. (1999). Implementation intentions: Strong effects of simple plans. *American Psychologist, 54*(7), 493.

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.

Hagger, M. S., Lonsdale, A., & Chatzisarantis, N. L. (2012). A theory-based intervention to reduce alcohol drinking in excess of guideline limits among undergraduate students. *British Journal of Health Psychology, 17*(1), 18–43.

Hagger, M. S., Lonsdale, A., Koka, A., Hein, V., Pasi, H., Lintunen, T., et al. (2012). An intervention to reduce alcohol consumption in undergraduate students using implementation intentions and mental simulations: A cross-national study. *International Journal of Behavioral Medicine, 19*(1), 82–96.

Hagger, M. S., & Luszczynska, A. (2014). Implementation intention and action planning interventions in health contexts: State of the research and proposals for the way forward. *Applied Psychology: Health and Well-Being, 6*(1), 1–47.

Hagger, M. S., Luszczynska, A., de Wit, J., Benyamini, Y., Burkert, S., Chamberland, P., et al. (2016). Implementation intention and planning interventions in health psychology: Recommendations from the synergy expert group for research and practice. *Psychology & Health, 31,* 1–26.

Hall, P. A., Zehr, C. E., Ng, M., & Zanna, M. P. (2012). Implementation intentions for physical activity in supportive and unsupportive environmental conditions: An experimental examination of intention–behavior consistency. *Journal of Experimental Social Psychology, 48*(1), 432–436.

Hogarth, L., & Chase, H. W. (2011). Parallel goal-directed and habitual control of human drug-seeking: Implications for dependence vulnerability. *Journal of Experimental Psychology: Animal Behavior Processes, 37*(3), 261–276.

Knäuper, B., McCollam, A., Rosen-Brown, A., Lacaille, J., Kelso, E., & Roseman, M. (2011). Fruitful plans: Adding targeted mental imagery to implementation intentions increases fruit consumption. *Psychology and Health, 26*(5), 601–617.

Knäuper, B., Roseman, M., Johnson, P. J., & Krantz, L. H. (2009). Using mental imagery to enhance the effectiveness of implementation intentions. *Current Psychology, 28*(3), 181–186.

Lengfelder, A., & Gollwitzer, P. M. (2001). Reflective and reflexive action control in patients with frontal brain lesions. *Neuropsychology, 15*(1), 80–100.

Linnebank, F. E., Kindt, M., & de Wit, S. (2018). Investigating the balance between goal-directed and habitual control in experimental and real-life settings. *Learning & Behavior, 46,* 1–14.

Luque, D., Beesley, T., Morris, R. W., Jack, B. N., Griffiths, O., Whitford, T. J., et al. (2017). Goal-directed and habit-like modulations of stimulus processing during reinforcement learning. *Journal of Neuroscience, 37*(11), 3009–3017.

Luszczynska, A., Sobczyk, A., & Abraham, C. (2007). Planning to lose weight: Randomized controlled trial of an implementation intention prompt to enhance weight reduction among overweight and obese women. *Health Psychology, 26*(4), 507.

Miles, F. J., Everitt, B. J., & Dickinson, A. (2003). Oral cocaine seeking by rats: Action or habit? *Behavioral Neuroscience, 117*(5), 927–938.

Milne, S., Orbell, S., & Sheeran, P. (2002). Combining motivational and volitional interventions to promote exercise participation: Protection motivation theory and implementation intentions. *British Journal of Health Psychology, 7*(2), 163–184.

Morris, R. W., Quail, S., Griffiths, K. R., Green, M. J., & Balleine, B. W. (2015). Corticostriatal control of goal-directed action is impaired in schizophrenia. *Biological Psychiatry, 77*(2), 187–195.

Neal, D. T., Wood, W., Wu, M., & Kurlander, D. (2011). The pull of the past: When do habits persist despite conflict with motives? *Personality and Social Psychology Bulletin, 37*(11), 1428–1437.

Neely, J. H. (1991). Semantic priming effects in visual word recognition: A selective review of current findings and theories. *Basic Processes in Reading: Visual Word Recognition, 11*, 264–336.

Nelson, A., & Killcross, S. (2006). Amphetamine exposure enhances habit formation. *The Journal of Neuroscience, 26*(14), 3805–3812.

Norman, P. (2011). The theory of planned behavior and binge drinking among undergraduate students: Assessing the impact of habit strength. *Addictive Behaviors, 36*(5), 502–507.

O'Connor, R. C., Ferguson, E., Scott, F., Smyth, R., McDaid, D., La Park, A., et al. (2017). A brief psychological intervention to reduce repetition of self-harm in patients admitted to hospital following a suicide attempt: A randomised controlled trial. *The Lancet Psychiatry, 4*(6), 451–460.

Oettingen, G. (2012). Future thought and behaviour change. *European Review of Social Psychology, 23*(1), 1–63.

Oettingen, G., Hönig, G., & Gollwitzer, P. M. (2000). Effective self-regulation of goal attainment. *International Journal of Educational Research, 33*(7), 705–732.

Orbell, S., & Verplanken, B. (2010). The automatic component of habit in health behavior: Habit as cue-contingent automaticity. *Health Psychology, 29*(4), 374.

Parkes, S. L., Furlong, T. M., Black, A. D., & Balleine, B. W. (2017). Intermittent feeding alters sensitivity to changes in reward value. *Appetite, 113*, 1–6.
Paul-Jordanov, I., Bechtold, M., & Gawrilow, C. (2010). Methylphenidate and if-then plans are comparable in modulating the P300 and increasing response inhibition in children with ADHD. *ADHD Attention Deficit and Hyperactivity Disorders, 2*(3), 115–126.
Pomp, S., Fleig, L., Schwarzer, R., & Lippke, S. (2013). Effects of a self-regulation intervention on exercise are moderated by depressive symptoms: A quasi-experimental study. *International Journal of Clinical and Health Psychology, 13*(1), 1–8.
Powers, T. A., Koestner, R., & Topciu, R. A. (2005). Implementation intentions, perfectionism, and goal progress: Perhaps the road to hell is paved with good intentions. *Personality and Social Psychology Bulletin, 31*(7), 902–912.
Rivis, A., & Sheeran, P. (2013). Automatic risk behavior: Direct effects of binge drinker stereotypes on drinking behavior. *Health Psychology, 32*(5), 571.
Robbins, T. W., Gillan, C. M., Smith, D. G., de Wit, S., & Ersche, K. D. (2012). Neurocognitive endophenotypes of impulsivity and compulsivity: Towards dimensional psychiatry. *Trends in Cognitive Sciences, 16*(1), 81–91.
Rubak, S., Sandbaek, A., Lauritzen, T., & Christensen, B. (2005). Motivational interviewing: A systematic review and meta-analysis. *The British Journal of General Practice, 55*(513), 305–312.
Sailer, P., Wieber, F., Pröpster, K., Stoewer, S., Nischk, D., Volk, F., et al. (2015). A brief intervention to improve exercising in patients with schizophrenia: A controlled pilot study with mental contrasting and implementation intentions (MCII). *BMC Psychiatry, 15*(1), 211.
Schoenmakers, T. M., de Bruin, M., Lux, I. F. M., Goertz, A. G., Van Kerkhof, D. H. A. T., & Wiers, R. W. (2010). Clinical effectiveness of attentional bias modification training in abstinent alcoholic patients. *Drug and Alcohol Dependence, 109*(1–3), 30–36.
Schwabe, L., & Wolf, O. T. (2009). Stress prompts habit behavior in humans. *The Journal of Neuroscience, 29*(22), 7191–7198.
Shah, R., Hunt, J., Webb, T. L., & Thompson, A. R. (2014). Starting to develop self-help for social anxiety associated with vitiligo: Using clinical significance to measure the potential effectiveness of enhanced psychological self-help. *The British Journal of Dermatology, 171*(2), 332–337.
Sheeran, P., Aubrey, R., & Kellett, S. (2007). Increasing attendance for psychotherapy: Implementation intentions and the self-regulation of attendance-related negative affect. *Journal of Consulting and Clinical Psychology, 75*(6), 853.
Sheeran, P., Webb, T. L., & Gollwitzer, P. M. (2005). The interplay between goal intentions and implementation intentions. *Personality & Social Psychology Bulletin, 31*(1), 87–98.
Singer, B. F., Fadanelli, M., Kawa, A. B., & Robinson, T. E. (2017). Are cocaine-seeking "habits" necessary for the development of addiction-like behavior in rats? *Journal of Neuroscience*, 2458–2417.
Sjoerds, Z., De Wit, S., Van Den Brink, W., Robbins, T., Beekman, A., Penninx, B., et al. (2013). Behavioral and neuroimaging evidence for overreliance on habit learning in alcohol-dependent patients. *Translational Psychiatry, 3*(12), e337.
Thorndike, E. L. (1911). *Animal intelligence: Experimental studies*. New York: The Macmillan Company.
Tiffany, S. T. (1990). A cognitive model of drug urges and drug-use behavior: Role of automatic and nonautomatic processes. *Psychological Review, 97*(2), 147–168.
Toli, A., Webb, T. L., & Hardy, G. E. (2016). Does forming implementation intentions help people with mental health problems to achieve goals? A meta-analysis of experimental studies with clinical and analogue samples. *British Journal of Clinical Psychology, 55*(1), 69–90.
Treasure, J. (2004). Motivational interviewing. *Advances in Psychiatric Treatment, 10*(5), 331–337.
Tricomi, E., Balleine, B. W., & O'Doherty, J. P. (2009). A specific role for posterior dorsolateral striatum in human habit learning. *European Journal of Neuroscience, 29*(11), 2225–2232.
van't Riet, J., Sijtsema, S. J., Dagevos, H., & De Bruijn, G. (2011). The importance of habits in eating behaviour. An overview and recommendations for future research. *Appetite, 57*(3), 585–596.

Varley, R., Webb, T. L., & Sheeran, P. (2011). Making self-help more helpful: A randomized controlled trial of the impact of augmenting self-help materials with implementation intentions on promoting the effective self-management of anxiety symptoms. *Journal of Consulting and Clinical Psychology, 79*(1), 123–128.

Veling, H., van Koningsbruggen, G. M., Aarts, H., & Stroebe, W. (2014). Targeting impulsive processes of eating behavior via the internet. Effects on body weight. *Appetite, 78*, 102–109.

Verhoeven, A. A., Adriaanse, M. A., de Vet, E., Fennis, B. M., & de Ridder, D. T. (2014). Identifying the 'if' for 'if-then' plans: Combining implementation intentions with cue-monitoring targeting unhealthy snacking behaviour. *Psychology & Health, 29*(12), 1476–1492.

Verhoeven, A. A., Adriaanse, M. A., Evers, C., & de Ridder, D. T. (2012). The power of habits: Unhealthy snacking behaviour is primarily predicted by habit strength. *British Journal of Health Psychology, 17*(4), 758–770.

Verhoeven, A. A., Adriaanse, M. A., Ridder, D. T., Vet, E., & Fennis, B. M. (2013). Less is more: The effect of multiple implementation intentions targeting unhealthy snacking habits. *European Journal of Social Psychology, 43*(5), 344–354.

Verplanken, B. (2006). Beyond frequency: Habit as mental construct. *British Journal of Social Psychology, 45*(3), 639–656.

Verplanken, B., & Aarts, H. (1999). Habit, attitude, and planned behaviour: Is habit an empty construct or an interesting case of goal-directed automaticity? *European Review of Social Psychology, 10*(1), 101–134.

Verplanken, B., & Orbell, S. (2003). Reflections on past behavior: A Self-Report index of habit strength. *Journal of Applied Social Psychology, 33*(6), 1313–1330.

Verplanken, B., Walker, I., Davis, A., & Jurasek, M. (2008). Context change and travel mode choice: Combining the habit discontinuity and self-activation hypotheses. *Journal of Environmental Psychology, 28*(2), 121–127.

Verplanken, B., & Wood, W. (2006). Interventions to break and create consumer habits. *Journal of Public Policy & Marketing, 25*(1), 90–103.

Voon, V., Derbyshire, K., Rück, C., Irvine, M. A., Worbe, Y., Enander, J., et al. (2015). Disorders of compulsivity: A common bias towards learning habits. *Molecular Psychiatry, 20*(3), 345–352.

Watkins, E. R., Mullan, E., Wingrove, J., Rimes, K., Steiner, H., Bathurst, N., et al. (2011). Rumination-focused cognitive-behavioural therapy for residual depression: Phase II randomised controlled trial. *The British Journal of Psychiatry, 199*(4), 317–322.

Watkins, E. R., Taylor, R. S., Byng, R., Baeyens, C., Read, R., Pearson, K., et al. (2012). Guided self-help concreteness training as an intervention for major depression in primary care: A Phase II randomized controlled trial. *Psychological Medicine, 42*(7), 1359–1371.

Watson, P., & de Wit, S. (2018). Current limits of experimental research into habits and future directions. *Current Opinion in Behavioral Sciences, 20*, 33–39.

Watson, P., Wiers, R. W., Hommel, B., Gerdes, V. E. A., & de Wit, S. (2017). Stimulus control over action for food in obese versus healthy-weight individuals. *Frontiers in Psychology, 8*, 580.

Webb, T. L., Ononaiye, M. S., Sheeran, P., Reidy, J. G., & Lavda, A. (2010). Using implementation intentions to overcome the effects of social anxiety on attention and appraisals of performance. *Personality and Social Psychology Bulletin, 36*(5), 612–627.

Webb, T. L., & Sheeran, P. (2007). How do implementation intentions promote goal attainment? A test of component processes. *Journal of Experimental Social Psychology, 43*(2), 295–302.

Webb, T. L., Sheeran, P., & Luszczynska, A. (2009). Planning to break unwanted habits: Habit strength moderates implementation intention effects on behaviour change. *British Journal of Social Psychology, 48*(3), 507–523.

Wiers, R. W., Eberl, C., Rinck, M., Becker, E. S., & Lindenmeyer, J. (2011). Retraining automatic action tendencies changes alcoholic patients' approach bias for alcohol and improves treatment outcome. *Psychological Science, 22*(4), 490–497.

Wood, W., & Neal, D. T. (2007). A new look at habits and the habit-goal interface. *Psychological Review, 114*(4), 843.

Wood, W., Witt, M. G., & Tam, L. (2005). Changing circumstances, disrupting habits. *Journal of Personality and Social Psychology, 88*(6), 918–933.

Chapter 17
Recovery Habits: A Habit Perspective on Recovery from Substance Use Disorder

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Introduction

The habit perspective of substance use disorder (SUD) (e.g. Everitt & Robbins, 2016) suggests habitual processes play a key role in SUD development and maintenance. This idea has spurred research aiming at identifying the habitual processes underlying SUD and how they could be modified. However, less attention has been paid to how habits can be leveraged in the maintenance of recovery from SUD. The purpose of this chapter is to examine through a habit perspective, how individuals with SUD can maintain recovery and generate new ideas about habits in recovery. Therefore, we first review the literature on long-term recovery predictors and examine habit formation during a few behavioural approaches for overcoming SUD. We also discuss whether sleep and physical exercise habits could contribute to relapse prevention.

Helpful recovery actions can be executed in a goal-oriented fashion, i.e. when one performs the action for the purpose of maintaining recovery. Helpful recovery actions can also be executed habitually, i.e. when one performs the action automatically in a given context because the action has been previously rewarding without necessary thinking at present of a particular future positive recovery consequence of the action. While both of these execution modes of healthy behaviours might be beneficial for recovery, healthy habits might require less effort than goal-directed behaviours (Wood & Rünger, 2016) and therefore be easier to sustain over the years. Therefore, we suggest that forming *recovery habits* might help maintain treatment gains throughout the years.

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Recent research estimates that more than 22 million individuals in the United States identify themselves as "*in recovery*" (Kelly, Bergman, Hoeppner, Vilsaint, & White, 2017). Various recovery definitions exist in the literature and no single one has received universal endorsement (Amaro & Schwarts, 2016; NASEM, 2016; White, 2012). In this chapter, we equate recovery to *remission*, which according to the Diagnostic and Statistical Manual of Mental Disorders, 5th edition (DSM-V; American Psychiatric Association, 2013) is present when an individual with a former SUD diagnosis has not met the SUD diagnostic criteria in the last 3 months or more (*early remission)* or in more than 12 months (*sustained remission*). While abstinence is not required for remission according to the DSM-V and recent thinking on recovery is moving away from a focus on abstinence to a focus on general well-being (Amaro & Schwarts, 2016), research still often uses abstinence as an index of recovery. Thus, many of the empirical findings reported here refer to abstaining completely from alcohol and other drugs (AOD).

Maintaining recovery also means avoiding *relapse* or the return to active and perpetual AOD use and associated SUD symptoms. In the first 3 years after initiating abstinence, 50% of individuals relapse (Dennis, Foss, & Scott, 2007), which might even be a conservative estimate. However, the rate of relapse declines over the years of sustained abstinence (Dennis et al., 2007). Further, relapse does not occur only once; individuals with SUD usually oscillate between periods of active use and abstinence or recovery (e.g. Brecht & Herbeck, 2014). Similarly to the term recovery, relapse is also not clearly defined (for a review, see Bradizza, Stasiewicz, & Paas, 2006). Gossop, Stewart, Browne, and Marsden (2002), for example, distinguish between *lapse* and *relapse,* with the former characterized as initiated use, which did not become regular thereafter and the latter referring to a larger percentage of days after abstinence violation being marked with use rather than abstinence. Despite such attempts for a more nuanced evaluation of relapse, the most commonly used research definition of relapse remains abstinence violation.

Understanding the cycle from SUD to recovery, which can be interrupted by lapses or relapse episodes, is crucial for grasping the complexity of maintaining long-term recovery. Individuals can be diagnosed with SUD again even after 20 years of continuous abstinence or recovery. For individuals committed to overcoming SUD, maintaining recovery remains an essential target even after 3 years of uninterrupted abstinence (Laudet & White, 2010). Thus, it is important to understand the predictors of sustained recovery among those affected by SUD and how healthy recovery habits can assist.

Known Predictors of Sustained Recovery

Prospective research on long-term recovery (e.g. more than 5 years) has been scarce (Laudet & Hill, 2015) with most clinical research trials following participants only for a few months after the termination of the treatment intervention (Laudet, Savage, & Mahmood, 2002). Studies of long-term recovery have used either interview data (e.g. Dennis et al., 2007) or online surveys (Kelly et al., 2017) and have mostly examined predictors retrospectively or cross-sectionally. Various predictors of long-term recovery have emerged from this research (Laudet et al., 2002): (1) receiving social support, (2) the personal negative consequences of AOD use and (3) affiliation with 12-step peer-support groups. The latter was also found to be a predictor of sustained abstinence in a study on alcohol use with a 60-year follow-up (Vaillant, 2003). Nevertheless, these studies are too few and the participants taking part in these might not always be representative of the general population (e.g. exclusively male participants in the Vaillant study). Therefore, more research is needed on predictors of long-term recovery examined in prospective designs particularly.

Recovery might cover a large proportion of one's life, thus there might be distinct stages of recovery (e.g. early vs. late), during which resilience and risk factors exert various levels of influence. Laudet and White (2008) found that while maintenance of recovery was predicted by baseline stress for individuals in the first 6 months of recovery, 12-step affiliation was a significant predictor of sustained recovery for individuals with 6–18 months of recovery and social support for those in recovery for more than 3 years. More research is needed on predictors of sustaining remission and their role over time.

Evaluating recovery from a habit perspective, we speculate that during early recovery, one might need to preferentially utilize habit-breaking strategies, such as avoiding AOD triggers through "vigilant monitoring" (e.g. Wood & Neal, 2016) or using implementation intentions to guide actions within habitual contexts (e.g. "If I see a bottle of alcohol, I will not drink from it, but rather look at pictures of my childen on my phone."; e.g. Moody, Tegge, Poe, Koffarnus, & Bickel, 2018; see also Chaps. 10 and 16 in this volume). These strategies might be easily applied quickly, because they do not require prolonged experiential learning. Similarly, Dennis et al. (2007) showed that active coping strategies (e.g. logical analysis) were more prominent during early abstinence, when individuals are required to deal with the immediate consequences of their use and increased mental health problems.

Later, more sophisticated habit-breaking practices such as changing the physical or social environment (i.e. "environmental reeingineering"; Wood & Neal, 2016; see also Chap. 11 in this volume) might be used. In one study, Laudet and White (2010) found that almost twice as many individuals who have been abstinent for 6–18 months mentioned housing needs as compared to those who have been in recovery less than 6 months, which might indicate the increased need to change the environment in order to maintain long-term recovery; a strategy noted by individuals in stable recovery in another study (Snoek, Levy, & Kennett, 2016). Dennis et al. (2007) also found a negative correlation between abstinence duration and AOD involvement of social contacts and that individuals alter their social networks as they move from active use to remission by surrounding themselves with fewer people who use substances (e.g. Zywiak et al., 2009).

At later stages of recovery, other priorities might become more prominent (e.g. physical fitness; Laudet & White, 2010) than a sole focus on maintaining sobriety or not using AOD. Then, building new healthy habits might be most successful in supporting recovery continuation. Indeed, evaluation of interview responses of participants in a study on SUD with a 3-year follow-up window showed that those in stable recovery, employed more varied strategies to maintain their recovery then those in unstable recovery or active substance use (Snoek et al., 2016). Interestingly, the study participants in stable recovery were also unable to elaborate on their strategies at follow-up, which Snoek and colleagues interpreted as participants' strategies becoming "less conscious" (2016). This might have occurred because the strategies have become more habitual over time. More studies need to evaluate the possibility of healthy recovery actions becoming more habitual as recovery progresses. Now, we turn to a discussion of specific recovery habits which can be fostered within the context of SUD management and that might benefit the maintenance of long-term recovery.

Habits Learned in Treatment

"12-Step" Programs

In the U.S., most individuals affected by SUD or in recovery have been involved with "*12-step groups*", such as Alcoholics Anonymous (AA) and Narcotics Anonymous (NA), at one point in their lifetime (e.g. Laudet & White, 2010). These 12-step groups are self-organized peer-support groups, in which individuals share recovery experiences and learn the "*steps*". The steps are a set of 12 directives (e.g. accepting powerlessness, belief in a higher power, evaluating one's moral deeds; Alcoholics Anonymous, 2001), which are worked on in succession. While some steps are required only during the period of initial AOD use cessation (e.g. admitting life had become unmanageable), others are intended as life-long practices (e.g. continually taking moral inventory and admitting when wrong). 12-step groups are spiritual in nature and their directives are rooted in the Christian movement of "Moral Re-Armement" (Austin, 1938). 12-step affiliation has been shown to predict long-term recovery (e.g. Dawson, Goldstein, Ruan, & Grant, 2012; Laudet et al., 2002).

The specific working mechanisms of the 12-step program are unclear. About half of the steps reflect the central tenet that the individual can no longer make decisions based on her own will and must instead turn her will over to a higher power. This is most directly stated in Step 3 "Made a decision to turn our will and our lives over to the care of God as we understood Him" (Alcoholics Anonymous, 2001) and reinforced in popular 12-step slogans like, "Let go and let God". There is controversy of whether this and other 12-step tenets are acceptable or helpful for all who walk into 12-step meetings (e.g. based on religious beliefs, gender; Bepko, 1992; Sanders, 2014) and "empowerment" self-help alternatives have started to emerge (e.g. Fenner & Gifford, 2012; Zemore, Lui, Mericle, Hemberg, & Kaskutas, 2018). Therefore, future research should compare "powerless" and "powerful" attitude creation and its effects on problematic SUD behaviours, in order to determine which one might be more beneficial for achieving and sustaining recovery.

It is unclear what happens specifically during the individual's endeavour to "turn their will over to a higher power." On the one hand, the broad nature of the 12-step program and its aim of guiding a person towards spiritual redemption (Galanter, Dermatis, & Sampson, 2014) appear inconsistent with a prominent role of habits. On the other hand, there is some reason to suspect habits may play an especially important role in the 12-step program. Relying on a higher power discourages *evaluation-based action selection*. In evaluation-based action, one or more alternatives are modeled mentally allowing a period of evaluation (Redish, 2016), which is the basis for action selection. Selection based on imagined consequence is the antithesis of habitual action, and may impede habit formation (e.g. Carden & Wood, 2018). If 12-Step ideology discourages evaluation-based action in domains covered by its directives, it may simultaneously facilitate habit formation.

Pilot Study

In order to begin to assess habits in 12-step recovery, we collaborated with two members of the 12-Step community (SW and HS, both of whom direct recovery programs) to develop a structured interview that probed "*12-step recovery habits*" in a pilot study. The interview evaluated 24 items related to 12-step ideology, ranging from specific actions (e.g. keeping daily journal) to general behaviour principles (e.g. practicing humility when you notice arrogance in yourself).

Participants abstinent from AOD use for at least 2 years rated how habitual a particular behaviour was ("*habit*"), and its "*importance*" in their recovery. Since our goal was to identify habits that could be subsequently scrutinized further, we encouraged participants to adopt a liberal definition of "habit":

> "*By "habit", we mean an action that you have repeated often in the past so that you now do it automatically,* ***without giving it much thought****. Of course, you might have thought a lot about the behaviour originally, and you might also have thought about alternative things to do. But once you practiced the new behaviour repeatedly, you began to do it* ***without considering other options***".

This definition allows for the classification of behaviours selected without conscious evaluation as habits, even if they do not occur in the same setting, and even if they vary in execution.

Participants also provided information about the "*frequency*" of the behaviour and whether there was a specific setting in which the behaviour occurred ("*cue*"). We do not discuss rating data for these due to factors complicating interpretation.[1]

[1] With regard to *frequency*, item heterogeneity made it difficult to interpret item-level variance. For some items, frequency was largely a function of opportunity (as in agreeing to requests for help); while for others, frequency was directly determined by personal decision (e.g., practicing self-affirmations). With regard to *cues*, participants reported different interpretations of the question, with some understanding "*cue*" as a stimulus in the external or internal environment (as intended), but others perceiving "*cue*" as synonymous with "*reason*" (e.g., "*I just know it is important, and that is my cue*.").

After discussing the 24 items, participants could identify and elaborate on any additional habits that were important to their recovery, but that had not been included in the interview. In order to facilitate participants' openness, the interviews were conducted by a project staff person with lived-experience in 12-step recovery (CA or AW).

Participants

Participants were recruited from the larger Los Angeles area, California. Sixteen participants (seven women) with a mean age of 38 years were interviewed. Abstinence duration was recorded for ten participants, who reported on average 6.8 consecutive years of abstinence (range = 2–17 years, SD = 4.7). Drug of choice was not recorded in this pilot study.

Results

Both open-ended answers and self-report ratings indicated that participants consider at least some of the 24 behaviours to fit our habit definition (see Table 17.1 for descriptive results). Further, all participants rated at least some of the behaviours as a highly habitual (5 on the habit rating), with this rating given for a median of 9 of the 24 behaviours. The behaviours most frequently endorsed as highly habitual were Item 11 "Being rigorously honest", Item 2 "Contacting someone in the program when your experiencing a challenge in your life, such as craving to drink.", and Item 5 "Keeping busy in positive ways.". In general, behaviours endorsed as habitual were also rated as being very important. Across participants, the mean importance rating was 4.79 for behaviours classified as highly habitual and 3.04 for behaviours endorsed as not habitual (with "not habitual" operationalized as a rating of 2 or less on the 5-point habit item).

The team listened to the interviews and identified many quotes that made reference to habit related behaviours. Many reflected on how some behaviours had come to feel habitual. In discussing highly habitual meeting attendance, for example, one participant said, "*I just know I should so I just do it, like suit up and show up.*" and another said, "*It's just like habit, reflex kind of thing.*" In discussing Item 2, a participant, who rated the item as highly habitual, said, "*it is something that is so like ingrained at this point so that when you have those thoughts you should be calling and reaching out like that's almost like registered in my brain that that is the right thing to do*". While discussing Item 17, another participant for whom the behaviour was highly habitual said, "*I have been doing the steps so long, you know I've been like talking about them and working them with other people that it's almost like when I start thinking about a resentment … I immediately go to my part*". An example explanation for a behaviour rated only as 4 of 5 on the habit rating scale was "*it is a habit but I still need to kind of like force, like the thought is a habit but the action is still like forced sometimes*". The participants' statements support the idea that

Table 17.1 Descriptive results from a pilot study on 12-step recovery habits ($N = 16$)

Item	Habit	Participants rating item as highly habitual	Importance
	Mean (SD)	Percentage	Mean (SD)
1. Going to meetings	4.38 (0.62)	43.8	4.72 (0.58)
2. Contacting someone in the program when your experiencing a challenge in your life, such as craving to drink	4.00 (1.33)	50.0	4.63 (0.62)
3. Saying yes whenever someone in recovery reaches out for help	4.40 (0.63)	43.8	4.63 (0.62)
4. Avoiding the places, people or situations that might be triggers for you	3.31 (1.78)	37.5	3.28 (1.79)
5. Keeping busy in positive ways	4.40 (0.83)	50.0	4.56 (1.26)
6. Staying connected to your sponsor	3.69 (1.40)	37.5	4.50 (0.52)
7. If you are a sponsor, acting on your role as a sponsor	3.92 (1.38)	31.3	4.54 (0.66)
8. Reaching out to newcomers	3.50 (1.46)	31.3	4.67 (0.72)
9. Keeping a daily journal	2.03 (2.13)	18.8	2.94 (1.95)
10. Writing a nightly inventory of your behaviour during the day	2.13 (2.28)	25.0	3.31 (1.85)
11. Being rigorously honest	4.44 (0.89)	62.5	4.88 (0.34)
12. Expressing feelings instead of stuffing them	3.67 (1.29)	37.5	4.53 (0.64)
13. Asking for a second opinion on big decisions	3.88 (1.26)	43.8	4.44 (0.81)
14. When committing a wrong, promptly making amends	3.69 (1.18)	25.0	4.59 (0.49)
15. Practicing prayer	3.81 (1.22)	37.5	4.25 (1.13)
16. Practicing meditation	3.00 (1.75)	18.8	4.00 (1.46)
17. Continually looking at my part in every conflict	3.94 (0.93)	31.3	4.81 (0.40)
18. Trying to move your thoughts and mood to a positive state when they are negative	3.94 (0.93)	31.3	4.81 (0.40)
19. Practicing gratitude	3.81 (1.22)	43.8	4.38 (0.81)
20. Practicing humility when you notice arrogance in yourself	3.60 (1.50)	37.5	4.44 (0.83)
21. Practicing personal affirmations	2.44 (1.79)	12.5	3.03 (1.76)
22. Pausing to breathe instead of acting impulsively	3.63 (1.36)	18.8	4.63 (0.81)
23. “Turning it over” (to a higher power)	3.31 (1.49)	25.0	4.63 (0.50)
24. ‘Starting over your day’ or identifying how your thoughts and behaviours have been hijacked by negativity or unfortunate events and resetting your mind to a happier or at least neutral place	3.25 (1.18)	12.5	4.25 (0.77)

Note: *Habit* and *importance* were rated on a Likert scale ranging from 0 (“definitely not a habit”/“not at important”) to 5 (“definitely a habit”/“essential”). *Highly habitual* refers to a rating of 5 on the *habit* question some behaviours have become habits and are often executed with limited intention, which is also captured by the habit Likert scale ratings.

The cues participants identified as important in triggering habits were often observations related to their emotional state. Two such examples (both related to Item 17) are, "*Um, usually I'll catch myself with like a tone of voice. When I'm blaming someone, I'm like listing all the things they did to fuck me over and I hear how like persecuted I sound. I hear like the self-righteous tone and I'll be like 'oh! I know what that tone is', and then I'll be like, 'I probably have a part in this too'*" and, "*…that tone of voice. Like when I just hear, it's almost like you can like hear your ego. Like you can hear ego being like, 'Nuh nuh nuh nuh nuh and nuh nuh nuh' and you're like, 'okay'. It is like a posture thing almost, you get like attitude in your posture. Whenever you get like diagonal in any way, it's a problem*".

Discussion

This pilot study indicates that members of the particular 12-step community we sampled feel that habits play an important role in their long-term recovery. Moreover, the self-reported habits were not limited to behavioural routines (e.g. going to meetings every Wednesday evening). They instead prominently included broad interpersonal behaviours like the maintenance of "rigorous honesty" and "contacting the sponsor". Interestingly, the item "*being rigorously honest*", rated as highly habitual by the largest percentage of our sample, relates to one of the aspects of recovery reported by all participants in the "What is recovery study?" (Witbrodt, Kaskutas, & Grella, 2015): "*being honest with myself*".

Obviously, these data are just a first step towards uncovering what 12-step habits are important in recovery, considering the small and non-representative sample of the pilot study. It is yet unclear the degree to which these self-reported habits or practices are truly habits. In addition, we cannot say whether someone who habitually engages in one of the above recovery habits would enjoy more protection from relapse relative to someone who has engaged in the same behaviours, but through deliberative evaluation-based decision-making. The evidence presented here does not provide a basis for answering such questions. However, given the high degree to which these 12-step program participants, who have been abstinent for more than 2 years, believed habitual control over recovery behaviours to be vital, the issue is certainly deserving of further investigation.

Cognitive-Behavioural Therapy

Among the effective evidence-based treatments for SUD is cognitive-behavioural therapy (CBT) (e.g. Carroll & Kiluk, 2017). CBT for SUD is a multi-component intervention based on the ideas of Marlatt and George (1984), in which clients learn to challenge maladaptive thoughts and behaviours related to AOD use, as well as establish new thinking and action patterns. There is no consistent evidence regarding its mechanisms of action (for a review, see Carroll & Kiluk, 2017). Here, we examine CBT through a habit perspective and emphasize how habit approaches can be used to increase the utility of CBT for long-term remission.

Among the important goals of CBT for SUD is to identify AOD triggers and associated thoughts and emotions. This skill is similar to the habit-breaking strategy of vigilant monitoring (Wood & Neal, 2016), since an individual should be able to discern cues in the environment prompting AOD use and monitor responses. This CBT component might be specifically useful for individuals in early remission, during which changing the old response patterns is of vital importance. Vigilant monitoring, however, might be challenging to maintain in the long-term, as it is often effortful (e.g. Watkins & Nolen-Hoeksema, 2014). Changing aspects of the environment can reduce the need for vigilant monitoring by creating major context shifts (Wood & Neal, 2016), which result in limiting AOD cues. Modifying the environment, however, is not always an available option for some individuals and demographic groups and does not eradicate the established association (e.g. Bouton, 2000) between the trigger and AOD use. Thus, vigilant monitoring skills can remain useful for individuals in long-term recovery when they are in specific places with abundance of AOD use triggers or faced with situations or emotional states that trigger cravings and/or their substance use.

Clients undergoing CBT also learn how to replace maladaptive habits with actions that can aid their recovery. For example, clients discover new pleasurable activities (e.g. a hobby), which they can enjoy instead of using AOD. While some see this as a form of habit replacement (Luskin, 2017), it is unclear whether habit formation takes place for these new behaviours. Clients are encouraged to practice these new actions repeatedly and repetition is required, but not sufficient for habit formation (Wood & Neal, 2016). In CBT, rather than emphasizing a stable context, therapists usually recommend that individuals try these new patterns in a variety of contexts (in order to generalize the learning; Bouton, 2000) or in contexts, where the original maladaptive habits occurred. In reality, this might slow down or even obstruct habit formation for these actions, as every context shift leads to an initial decline of the frequency with which an action is executed (Bouton, Todd, & León, 2014). In addition, in therapies aiming at reversing disturbing habits in tic disorders (Azrin & Nunn, 1973; McGuire et al., 2015), it is recommended that the new responses are orthogonally different to the target actions. It is not immediately clear what such an action would be for AOD use and whether other pleasurable activities would be distinct enough to replace the old habit. Future research should examine whether the type of action used to substitute the AOD use habit makes a difference in clinical outcomes.

Further, besides the internal reinforcement (e.g. excitement) one might receive from executing novel actions, clients often receive positive social feedback from the therapist (a strong reinforcer) and sometimes even material goods (e.g. gift cards when engaging in contingency management treatment, Higgins & Petry, 1999). The schedule of reinforcement affects action frequency and the longevity of the repetitive action execution when reinforcement is withdrawn (Ferster & Skinner, 1957). Habits are best learned when rewards are presented on an *intermittent schedule* (Wood & Neal, 2016) and when rewards are delivered in way that is difficult to predict (Ferster & Skinner, 1957) or randomly (Wood & Neal, 2016). Such variability in reinforcement might be challenging to execute during treatment, but therapists should assure that rewards are not presented all the time and only within the treatment setting. Therapist-delivered reinforcers would not be available following the completion of CBT. Such removal of reinforcement of new responses modulates the strength of the resurgence of previously learned actions in animals (Schepers & Bouton, 2015) and similar processes might occur following SUD CBT. Thus, it is important that reinforcers are delivered in a way that can continue following treatment completion. Further, the value of a particular reinforcement might change over time, while one is in recovery. The reinforcement value of a particular reward should be examined on a regular basis and reinforcement modified according to the individual's subjective evaluation of its rewarding properties at every given moment. Since the process of recovery is considered life-long, it is important that adaptive reinforcement for recovery is maintained.

Mindfulness

Mindfulness-based relapse prevention (MBRP; e.g. Bowen et al., 2009) treatments have also been shown to reduce AOD use in a number of clinical trials for a range of SUDs (Li, Howard, Garland, McGovern, & Lazar, 2017) (but see S. Grant et al., 2017). The MBRP protocol combines mindfulness-based principles with the evidence-based relapse prevention protocol for SUD (Marlatt & George, 1984). Mindfulness-based interventions (MBIs) aim at promoting a non-judgemental awareness and acceptance of internal and external experiences, as well as the ability to observe them without responding automatically (Kabat-Zinn, 2009), an approach markedly different from the avoidant-based coping in CBT.

Early in recovery, MBRP might help individuals disengage the habitual response of AOD use from the AOD triggers. MBRP and other mindfulness-based interventions have been suggested to reduce the likelihood to act in a habitual way (Brewer, Elwafi, & Davis, 2013), while at the same time increase goal-orientedness (Tang, Hölzel, & Posner, 2015). However, while evidence exist for some theory-based underlying mechanisms of MBRP (e.g. reductions in AOD craving, Witkiewitz, Lustyk, & Bowen, 2013), gaps remain in our understanding of how meaningful change is achieved, as well as the long-term effectiveness of MBRP (e.g. Witkiewitz & Black, 2014). We are currently conducting an RCT of an MBRP intervention for women in residential SUD treatment (Amaro & Black, 2017) in order to evaluate its efficacy and shed further light on key working mechanisms. Additionally, the efficacy of MBIs and MBRP for individuals in later stages of recovery has not been empirically investigated (Wilson et al., 2017).

During MBRP, individuals engage in mindfulness practices, such as guided meditation or yoga, for instance, and are suggested to set aside dedicated time to practice mindfulness outside of treatment sessions. These practices aim to enhance participants' skills in bringing awareness to thoughts, emotions and sensations without reacting. Only a few studies have systematically examined the effects of practice outside of the therapeutic sessions on clinical outcomes (Manuel, Somohano, & Bowen, 2017) and evidence on the importance of this intervention ingredient is limited (Wilson et al., 2017). While an association between increased home practice and improved psychological indices has been previously reported, findings have been mixed for the relationship of practice with smoking frequency following smoking cessation MBIs (e.g. Goldberg, Del Re, Hoyt, & Davis, 2014). Only one study has examined drug use outcomes in a relatively small sample and found that the interaction between craving and time spent practicing mindfulness outside sessions predicted AOD use, so that those engaging in more practice used on fewer days even when they experienced strong craving (Enkema & Bowen, 2017).

Regular practice might lead to mindful responding becoming habitual. While the a-priori modus operandi might be to act upon AOD triggers or react emotionally to provoking stimuli, non-reactivity might become habitual following regular mindfulness practice. However, the amount of training and ongoing practice required for such a shift has not been established (e.g. Witkiewitz & Black, 2014). Further, this mindful-responding habit might also need to be triggered, similarly to other habits. In a study of participants in a mindfulness-based stress reduction program, researchers showed that mindful responding was higher on days when participants engaged in mindfulness practice than days without practice (Lacaille et al., 2014). Thus, it might be important to establish mindfulness practice as a habit, especially in the later stages of recovery when individuals no longer receive active treatment and introduce cues, which might serve as triggers for responding mindfully. While this is integrated into mindfulness training for example, when the mindfulness teacher suggests that one engage in short-term mindfulness practice at convenient moments (e.g. when stopping at a red light), this is underemphasized and the appropriateness of the "triggers" is not systematically examined during the MBI.

Those in long-term recovery might need to practice mindfulness at particular times within a stable context in order to assure habit formation and increase the likelihood of continuing to benefit from their MBRP experiences. One recent study showed that among adolescents determined to continue engaging in mindfulness practice following a meditation retreat, commitment to "action plans" or establishing specific set of steps to guide goal completion led to increased meditation frequency (Galla, Baelen, Duckworth, & Baime, 2016). The utility of forming a habit for mindfulness practice through pre-planning during or after MBRP is yet to be established for those in long-term remission. We are not aware of any studies recording the engagement in mindfulness practices among individuals in long-term recovery following MBRP or in general.

Other Healthy Habits as Potential Recovery Habits

The most common activities associated with the term *healthy habits* are healthy sleeping, physical exercise and nutrition. These habits might be important for individuals in recovery as well, even though they are often not considered in any systematic way in SUD treatment. Next, we take a look at two such habits, sleep and physical exercise, and their role in recovery. While nutrition might also assist in avoiding relapse, research on nutrition in SUD and recovery is insufficient (see Jeynes & Gibson, 2017 for a review of available empirical evidence).

Sleep

Alcohol and other substances have a profound impact on sleep (for a review, see Conroy & Arnedt, 2014). Insomnia can co-occur with SUD and AOD withdrawal and abstinence do not abolish all sleep disturbances (for a review, see Brower, 2016) and persistent sleep difficulties increase relapse likelihood following SUD treatment (e.g. Brower & Perron, 2010). While research has focused on alcohol use disorder, sleep problems might be a risk factor for relapse for both alcohol and drug use disorders (Brower & Perron, 2010). Thus, establishing healthy sleep habits might be valuable for sustaining recovery regardless of substance of abuse and thus worthy of an in-depth investigation.

It is common knowledge that bad habits (e.g. drinking coffee before bedtime) can disturb sleep and that other habits can assist healthy sleep (Posner & Gehrman, 2011). Good sleep practices are promoted as a set of *sleep hygiene* behaviours (e.g. Irish, Kline, Gunn, Buysse, & Hall, 2015) and include, but are not limited to, going to bed at the same time and having bedtime rituals (e.g. reducing ambient light before going to bed). These actions need to be executed consistently in order to be most effective (Schubert & Todd Arnedt, 2017), thus the more habitual they are, the more easy and efficacious they would be. Therefore, sleep interventions focused on establishing healthy sleeping habits might be useful for those in recovery from SUD. We are not aware of any efficacy examinations of sleep interventions for SUD. However, it is possible that the utility of such interventions will be limited to only a portion of individuals affected by SUD, since some people might have little control over factors, which might disturb sleep. For example, parents of young children may have their sleep routine or sleep time interrupted by children's needs, and low-income neighborhoods present challenges (e.g. noise, lack of safety) to sleeping properly (e.g. Fuller-Rowell et al., 2016) and individuals with SUD within those neighborhoods might not have the resources to change their environments.

Physical Exercise

Engagement in regular physical exercise (PE) improves fitness and general health, an important need for those in long-term recovery (Laudet & White, 2010). PE can also assist in achieving SUD remission. While results on the efficacy of PE interventions for SUD have been encouraging (Wang, Wang, Wang, Li, & Zhou, 2014), more research is needed to fully understand their working mechanisms, what populations could benefit most and whether they can be effective in the long term (e.g. Lynch, Peterson, Sanchez, Abel, & Smith, 2013). Lynch et al. (2013) propose that PE needs to be introduced during AOD withdrawal, because of its effects on the dopaminogetic system and negative symptoms. However, it is unclear how much the severe withdrawal symptoms of some drugs would interfere with both the needed motivation and the physical ability for PE. Lynch et al. (2013) suggest that after a period of sustained abstinence, susceptibility to relapse might be increased by PE, since its stimulation of the brain reward pathways at that time might be akin to that of AOD consumption. The authors note that factors such as PE intensity, drug use history, individual characteristics and other factors affecting the individual at the moment of PE initiation might moderate the effectiveness of a PE regiment. Future research should examine in-depth the effects of PE on recovery at various stages in the recovery process and include studies that provide insight into the underlying physiological and psychological mechanisms at work.

Low adherence and high dropout are major issues for PE treatments (Weinstock, Farney, Elrod, Henderson, & Weiss, 2017). Participants who complete a PE program benefit more than individuals who do not (Trivedi et al., 2017). While this might be an indication of the importance of PE dosage, motivation, concurrent health problems and accessibility to PE and other resources might all contribute to its reduced effectiveness among individuals with low adherence. In order to increase overall adherence to a PE intervention, Weinstock et al. (2017) are currently combining motivational interviewing and contingency management with a PE intervention. Habit approaches (e.g. Wood & Neal, 2016) can also be used to build a PE routine, which can help in achieving remission (see also Chap. 6 in this volume for more information on habit and physical activity). Making physical exercise or part of it (e.g. its initiation) habitual might increase the effectiveness of PE interventions for maintaining recovery and assure regular practice.

While the PE intensity does not seem to mediate the PE intervention's effectiveness (Wang et al., 2014), it is unclear how intensity might affect adherence or the PE habit formation. Varying rewards presentation is an effective habit intervention (Wood & Neal, 2016), thus varying exercise intensity might be beneficial, since different levels of intensity might lead to various experiences of gratification (Ekkekakis, Parfitt, & Petruzzello, 2011), mastery and accomplishment. While a high intensity workout might have stronger effects on the cardiovascular system, for example, a low intensity workout might be rewarding and produce feelings of mastery. We are not aware of any studies that have examined a variable intensity PE intervention for SUD. Physical ability and other health issues might prevent certain individuals from undertaking high intensity PE, therefore PE interventions need to be developed keeping such limitations in mind.

Conclusions

Despite continuous efforts to improve SUD treatments, relapse rates remain regrettably high. We know very little about long-term recovery and what can reduce relapse vulnerability. Systematic efforts are needed to better understand the pathways to long-term recovery and the ebbs and flows of risk and protective factors at play during different recovery periods or stages. Such new knowledge could be used to develop efficacious approaches to maintain recovery over the years (e.g. Dennis et al., 2007). Here, we propose that building healthy habits of recovery can help sustain it in the long run. Further, we emphasize that the importance of these recovery habits might differ between individuals and across recovery stages. Thus, future research should investigate what healthy habits play the strongest protective role at particular recovery phases.

Habit Research in Action

Recovery from substance use disorder is a process, which can span many years. As a chronic health condition, the process of SUD recovery is likely lifelong. Various stages of recovery might exist (e.g. Laudet & White, 2008). Therefore, research should evaluate individuals not only in early recovery but also those who have already spent years in recovery. In this chapter, we have proposed that healthy *recovery habits* might contribute to success in lifelong recovery. This idea is speculative at the present time, but worth scientific investigation. Researchers interested in the topic should consider:

1. Evaluating how attitudes towards "higher power" shaped by 12-step affiliation relate to habit formation
2. Studying behavioural patterns acquired through formal and informal treatment for substance use disorder and their habitual nature
3. Examining changes in reinforcement of healthy behaviours throughout various stages of recovery
4. Paying attention to healthy habits such as sleep and physical exercise and their role in recovery
5. Analyzing with qualitative methods descriptions of actions considered important for maintaining recovery

Research on *recovery habits* should go beyond a frequency metric, which might depend on resource accessibility, and evaluate both specific actions, as well as behaviours stemming from learned attitudes.

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References

Alcoholics Anonymous. (2001). *Big book* (4th ed.). Alcoholics Anonymous Publishing.

Amaro, H., & Black, D. S. (2017). Moment-by-Moment in Women's Recovery: Randomized controlled trial protocol to test the efficacy of a mindfulness-based intervention on treatment retention and relapse prevention among women in residential treatment for substance use disorder. *Contemporary Clinical Trials, 62*, 146–152. https://doi.org/10.1016/j.cct.2017.09.004

Amaro, H., & Schwarts, L. (2016). Measuring recovery from substance use and mental disorder. Discussion Brief. Prepared for the May 26, 2016 meeting of the National Academies of Sciences, Engineering, and Medicine Standing Committee on Integrating New Behavioral Health Measures into The Substance Abuse and Mental Health Services Administration's Data Collection Programs. Retrieved from http://sites.nationalacademies.org/DBASSE/CNSTAT/Behavioral_Health_Measures_Committee/index.htm

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders—V* (5th ed.). Washington, D.C.: American Psychiatric Association.

Austin, H. W. (Ed.). (1938). *Moral rearmament: The battle for peace*. William Heinemann, Limited.

Azrin, N. H., & Nunn, R. G. (1973). Habit-reversal: A method of eliminating nervous habits and tics. *Behaviour Research and Therapy, 11*(4), 619–628. https://doi.org/10.1016/0005-7967(73)90119-8

Bepko, C. (1992). *Feminism and addiction*. New York: Routledge.

Bouton, M. E. (2000). A learning theory perspective on lapse, relapse, and the maintenance of behavior change. *Health Psychology, 19*(Suppl. 1), 57–63. https://doi.org/10.1037/0278-6133.19.Suppl1.57

Bouton, M. E., Todd, T. P., & León, S. P. (2014). Contextual control of discriminated operant behavior. *Journal of Experimental Psychology: Animal Learning and Cognition, 40*(1), 92–105. https://doi.org/10.1037/xan0000002

Bowen, S., Chawla, N., Collins, S. E., Witkiewitz, K., Hsu, S., Grow, J., et al. (2009). Mindfulness-based relapse prevention for substance use disorders: A pilot efficacy trial. *Substance Abuse, 30*(4), 295–305. https://doi.org/10.1080/08897070903250084

Bradizza, C. M., Stasiewicz, P. R., & Paas, N. D. (2006). Relapse to alcohol and drug use among individuals diagnosed with co-occurring mental health and substance use disorders: A review. *Clinical Psychology Review, 26*(2), 162–178. https://doi.org/10.1016/j.cpr.2005.11.005

Brecht, M.-L., & Herbeck, D. (2014). Time to relapse following treatment for methamphetamine use: A long-term perspective on patterns and predictors. *Drug and Alcohol Dependence, 139*, 18–25. https://doi.org/10.1016/j.drugalcdep.2014.02.702

Brewer, J. A., Elwafi, H. M., & Davis, J. H. (2013). Craving to quit: Psychological models and neurobiological mechanisms of mindfulness training as treatment for addictions. *Psychology of Addictive Behaviors, 27*(2), 366–379. https://doi.org/10.1037/a0028490

Brower, K. J. (2016). Assessing and treating insomnia related to alcohol use disorders. *Current Addiction Reports, 3*(1), 98–108. https://doi.org/10.1007/s40429-016-0083-1

Brower, K. J., & Perron, B. E. (2010). Sleep disturbance as a universal risk factor for relapse in addictions to psychoactive substances. *Medical Hypotheses, 74*(5), 928–933. https://doi.org/10.1016/j.mehy.2009.10.020

Carden, L., & Wood, W. (2018). Habit formation and change. *Current Opinion in Behavioral Sciences, 20*, 117–122. https://doi.org/10.1016/j.cobeha.2017.12.009

Carroll, K. M., & Kiluk, B. D. (2017). Cognitive behavioral interventions for alcohol and drug use disorders: Through the stage model and back again. *Psychology of Addictive Behaviors, 31*(8), 847–861. https://doi.org/10.1037/adb0000311

Conroy, D. A., & Arnedt, J. T. (2014). Sleep and substance use disorders: An update. *Current Psychiatry Reports, 16*(10), 487. https://doi.org/10.1007/s11920-014-0487-3

Dawson, D. A., Goldstein, R. B., Ruan, W. J., & Grant, B. F. (2012). Correlates of recovery from alcohol dependence: A prospective study over a 3-year follow-up interval. *Alcoholism: Clinical and Experimental Research, 36*(7), 1268–1277. https://doi.org/10.1111/j.1530-0277.2011.01729.x

Dennis, M. L., Foss, M. A., & Scott, C. K. (2007). An eight-year perspective on the relationship between the duration of abstinence and other aspects of recovery. *Evaluation Review, 31*(6), 585–612. https://doi.org/10.1177/0193841X07307771

Ekkekakis, P., Parfitt, G., & Petruzzello, S. J. (2011). The pleasure and displeasure people feel when they exercise at different intensities. *Sports Medicine, 41*(8), 641–671.

Enkema, M. C., & Bowen, S. (2017). Mindfulness practice moderates the relationship between craving and substance use in a clinical sample. *Drug and Alcohol Dependence, 179*, 1–7. https://doi.org/10.1016/j.drugalcdep.2017.05.036

Everitt, B. J., & Robbins, T. W. (2016). Drug addiction: Updating actions to habits to compulsions ten years on. *Annual Review of Psychology, 67*(1), 150807174122003. https://doi.org/10.1146/annurev-psych-122414-033457

Fenner, R. M., & Gifford, M. H. (2012). Women for Sobriety: 35 years of challenges, changes, and continuity. *Journal of Groups in Addiction and Recovery, 7*(2–4), 142–170.

Ferster, C. B., & Skinner, B. F. (1957). *Schedules of reinforcement*. East Norwalk, CT: Appleton-Century-Crofts. https://doi.org/10.1037/10627-000

Fuller-Rowell, T. E., Curtis, D. S., El-Sheikh, M., Chae, D. H., Boylan, J. M., & Ryff, C. D. (2016). Racial disparities in sleep: The role of neighborhood disadvantage. *Sleep Medicine, 27–28*, 1–8. https://doi.org/10.1016/j.sleep.2016.10.008

Galanter, M., Dermatis, H., & Sampson, C. (2014). Spiritual awakening in alcoholics anonymous: Empirical findings. *Alcoholism Treatment Quarterly, 32*(2–3), 319–334. https://doi.org/10.1080/07347324.2014.907058

Galla, B. M., Baelen, R. N., Duckworth, A. L., & Baime, M. J. (2016). Mindfulness, meet self-regulation: Boosting out-of-class meditation practice with brief action plans. *Motivation Science, 2*(4), 220–237. https://doi.org/10.1037/mot0000045

Goldberg, S. B., Del Re, A. C., Hoyt, W. T., & Davis, J. M. (2014). The secret ingredient in mindfulness interventions? A case for practice quality over quantity. *Journal of Counseling Psychology, 61*(3), 491–497. https://doi.org/10.1037/cou0000032

Gossop, M., Stewart, D., Browne, N., & Marsden, J. (2002). Factors associated with abstinance, lapse or relapse to heroin use after residential treatment: Protective effect of coping responses. *Addiction, 97*, 1259–1267.

Grant, S., Colaiaco, B., Motala, A., Shanman, R., Booth, M., Sorbero, M., et al. (2017). Mindfulness-based relapse prevention for substance use disorders: A systematic review and meta-analysis. *Journal of Addiction Medicine, 11*(5), 386–396. https://doi.org/10.1097/ADM.0000000000000338

Higgins, S. T., & Petry, N. M. (1999). Contingency management. *Alcohol Research and Health, 23*, 2.

Irish, L. A., Kline, C. E., Gunn, H. E., Buysse, D. J., & Hall, M. H. (2015). The role of sleep hygiene in promoting public health: A review of empirical evidence. *Sleep Medicine Reviews, 22*, 23–36.

Jeynes, K. D., & Gibson, E. L. (2017). The importance of nutrition in aiding recovery from substance use disorders: A review. *Drug and Alcohol Dependence, 179*, 229–239. https://doi.org/10.1016/j.drugalcdep.2017.07.006

Kabat-Zinn, J. (2009). *Wherever you go, there you are: Mindfulness meditation in everyday life.* Hachette, UK.

Kelly, J. F., Bergman, B., Hoeppner, B. B., Vilsaint, C., & White, W. L. (2017). Prevalence and pathways of recovery from drug and alcohol problems in the United States population: Implications for practice, research, and policy. *Drug and Alcohol Dependence, 181*, 162–169. https://doi.org/10.1016/j.drugalcdep.2017.09.028

Lacaille, J., Ly, J., Zacchia, N., Bourkas, S., Glaser, E., & Knäuper, B. (2014). The effects of three mindfulness skills on chocolate cravings. *Appetite, 76*, 101–112. https://doi.org/10.1016/j.appet.2014.01.072

Laudet, A. B., & Hill, T. (2015). Life experiences in active addiction and in recovery among treated and untreated persons: A national study. *Journal of Addictive Diseases, 34*(1), 18–35. https://doi.org/10.1080/10550887.2014.975615

Laudet, A. B., Savage, R., & Mahmood, D. (2002). Pathways to long-term recovery: A preliminary investigation. *Journal of Psychoactive Drugs, 34*(3), 305–311. https://doi.org/10.1080/02791072.2002.10399968

Laudet, A. B., & White, W. L. (2008). Recovery capital as prospective predictor of sustained recovery, life satisfaction, and stress among former poly-substance users. *Substance Use & Misuse, 43*(1), 27–54. https://doi.org/10.1080/10826080701681473

Laudet, A. B., & White, W. (2010). What are your priorities right now? Identifying service needs across recovery stages to inform service development. *Journal of Substance Abuse Treatment, 38*(1), 51–59. https://doi.org/10.1016/j.jsat.2009.06.003

Li, W., Howard, M. O., Garland, E. L., McGovern, P., & Lazar, M. (2017). Mindfulness treatment for substance misuse: A systematic review and meta-analysis. *Journal of Substance Abuse Treatment, 75*, 62–96. https://doi.org/10.1016/j.jsat.2017.01.008

Luskin, B. J. (2017). *The habit replacement loop*. Retrieved February 2, 2018, from https://www.psychologytoday.com/blog/the-media-psychology-effect/201705/the-habit-replacement-loop

Lynch, W. J., Peterson, A. B., Sanchez, V., Abel, J., & Smith, M. A. (2013). Exercise as a novel treatment for drug addiction: A neurobiological and stage-dependent hypothesis. *Neuroscience & Biobehavioral Reviews, 37*(8), 1622–1644. https://doi.org/10.1016/j.neubiorev.2013.06.011

Manuel, J. A., Somohano, V. C., & Bowen, S. (2017). Mindfulness practice and its relationship to the five-facet mindfulness questionnaire. *Mindfulness, 8*(2), 361–367. https://doi.org/10.1007/s12671-016-0605-x

Marlatt, G. A., & George, W. H. (1984). Relapse prevention: Introduction and overview of the model. *Addiction, 79*(3), 261–273. https://doi.org/10.1111/j.1360-0443.1984.tb00274.x

McGuire, J. F., Ricketts, E. J., Piacentini, J., Murphy, T. K., Storch, E. A., & Lewin, A. B. (2015). Behavior therapy for tic disorders: An evidenced-based review and new directions for treatment research. *Current Developmental Disorders Reports, 2*(4), 309–317. https://doi.org/10.1007/s40474-015-0063-5

Moody, L. N., Tegge, A. N., Poe, L. M., Koffarnus, M. N., & Bickel, W. K. (2018). To drink or to drink less? Distinguishing between effects of implementation intentions on decisions to drink and how much to drink in treatment-seeking individuals with alcohol use disorder. *Addictive Behaviors, 83*, 64–71. https://doi.org/10.1016/j.addbeh.2017.11.010

National Academies of Sciences, Engineering, and Medicine. (2016). *Measuring recovery from substance use or mental disorders: Workshop summary.* K. Marton, Rapporteur. Committee on National Statistics and Board on Behavioral, Cognitive, and Sensory Sciences, Division of Behavioral and Social Sciences and Education. Board on Health Sciences Policy, Health and Medicine Division. Washington, DC: The National Academies Press. https://doi.org/10.17226/23589.

Posner, D., & Gehrman, P. R. (2011). Sleep hygiene. In M. Perlis, M. Aloia, & B. Kuhn (Eds.), *Behavioral treatments for sleep disorders* (1st ed., pp. 31–43).

Redish, A. D. (2016). Vicarious trial and error. *Nature Reviews Neuroscience, 17*(3), 147–159. https://doi.org/10.1038/nrn.2015.30

Sanders, J. M. (2014). Introduction: Women, addiction, and the double standard. In *Women in narcotics anonymous: Overcoming stigma and shame*. New York: Palgrave Macmillan.

Schepers, S. T., & Bouton, M. E. (2015). Effects of reinforcer distribution during response elimination on resurgence of an instrumental behavior. *Journal of Experimental Psychology: Animal Learning and Cognition, 41*(2), 179–192. https://doi.org/10.1037/xan0000061

Schubert, J. R., & Todd Arnedt, J. (2017). Management of insomnia in patients with alcohol use disorder. *Current Sleep Medicine Reports, 3*(2), 38–47. https://doi.org/10.1007/s40675-017-0066-3

Snoek, A., Levy, N., & Kennett, J. (2016). Strong-willed but not successful: The importance of strategies in recovery from addiction. *Addictive Behaviors Reports, 4*, 102–107. https://doi.org/10.1016/j.abrep.2016.09.002

Tang, Y.-Y., Hölzel, B. K., & Posner, M. I. (2015). The neuroscience of mindfulness meditation. *Nature Reviews Neuroscience, 16*(4), 1–13. https://doi.org/10.1038/nrn3916

Trivedi, M. H., Greer, T. L., Rethorst, C. D., Carmody, T., Grannemann, B. D., Walker, R., et al. (2017). Randomized controlled trial comparing exercise to health education for stimulant use disorder. *The Journal of Clinical Psychiatry, 78*(8), 1075–1082. https://doi.org/10.4088/JCP.15m10591

Vaillant, G. E. (2003). A 60-year follow-up of alcoholic men. *Addiction, 98*(8), 1043–1051. https://doi.org/10.1046/j.1360-0443.2003.00422.x

Wang, D., Wang, Y., Wang, Y., Li, R., & Zhou, C. (2014). Impact of physical exercise on substance use disorders: A meta-analysis. *PLoS One, 9*(10), e110728. https://doi.org/10.1371/journal.pone.0110728

Watkins, E., & Nolen-Hoeksema, S. (2014). A habit-goal framework of depressive rumination. *Journal of Abnormal Psychology, 123*(1), 24–34. https://doi.org/10.1037/a0035540

Weinstock, J., Farney, M. R., Elrod, N. M., Henderson, C. E., & Weiss, E. P. (2017). Exercise as an adjunctive treatment for substance use disorders: Rationale and intervention description. *Journal of Substance Abuse Treatment, 72*, 40–47. https://doi.org/10.1016/j.jsat.2016.09.002

White, W. L. (2012). *Recovery/remission from substance use disorders: An analysis of reported outcomes in 415 scientific reports, 1868-2011*. Pittsburgh, PA.

Wilson, A. D., Roos, C. R., Robinson, C. S., Stein, E. R., Manuel, J. A., Enkema, M. C., et al. (2017). Mindfulness-based interventions for addictive behaviors: Implementation issues on the road ahead. *Psychology of Addictive Behaviors, 31*(8), 888–896. https://doi.org/10.1037/adb0000319

Witbrodt, J., Kaskutas, L. A., & Grella, C. E. (2015). How do recovery definitions distinguish recovering individuals? Five typologies. *Drug and Alcohol Dependence, 148*, 109–117. https://doi.org/10.1016/j.drugalcdep.2014.12.036

Witkiewitz, K., & Black, D. S. (2014). Unresolved issues in the application of mindfulness-based interventions for substance use disorders. *Substance Use & Misuse, 49*(5), 601–604. https://doi.org/10.3109/10826084.2014.852797

Witkiewitz, K., Lustyk, M. K. B., & Bowen, S. (2013). Retraining the addicted brain: A review of hypothesized neurobiological mechanisms of mindfulness-based relapse prevention. *Psychology of Addictive Behaviors, 27*(2), 351.

Wood, W., & Neal, D. T. (2016). Healthy through habit: Interventions for initiating & maintaining behavior change. *Behavioral Science & Policy, 2*(1), 71–83.

Wood, W., & Rünger, D. (2016). Psychology of habit. *Annual Review of Psychology, 67*, 289–314.

Zemore, S. E., Lui, C., Mericle, A., Hemberg, J., & Kaskutas, L. A. (2018). A longitudinal study of the comparative efficacy of Women for Sobriety, LifeRing, SMART Recovery, and 12-step groups for those with AUD. *Journal of Substance Abuse Treatment, 88*, 18–26. https://doi.org/10.1016/j.jsat.2018.02.004

Zywiak, W. H., Neighbors, C. J., Martin, R. A., Johnson, J. E., Eaton, C. A., & Rohsenow, D. J. (2009). The Important People Drug and Alcohol interview: Psychometric properties, predictive validity, and implications for treatment. *Journal of Substance Abuse Treatment, 36*(3), 321–330. https://doi.org/10.1016/j.jsat.2008.08.001

Part III
Critical Questions and Prospects

Chapter 18
A Critical Review of Habit Theory of Drug Dependence

Lee Hogarth

Introduction

Defining Goal-Directed and Habitual Instrumental Behaviour

Purposeful instrumental behaviour can be explained by both intentional and automatic theories of behavioural control (Heyes & Dickinson, 1990). On the goal-directed account, instrumental behaviour to obtain a reward is controlled by knowledge of the causal contingency between the instrumental response and the rewarding outcome, and knowledge of the predictive contingency between the current state of the agent and the value of the reward in that state. For example, the value of food is expected to be higher in a state of hunger, which motivates instrumental behaviour known to produce food (Dickinson, 1997). By contrast, according to the habit account, instrumental behaviour can also be controlled by S-R associations between external stimulus context (S) and the response (R), which are strengthened by contiguous reinforcement. That is, if in a particular stimulus context a response is performed which produces reward, the link between the stimulus context and the response is strengthened by the reward, such that the stimulus becomes able to elicit the response. This habitual form of behavioural control is automatic in the sense that the S elicits the R without retrieving an expectation of the reward to be obtained. It has been argued that drug addiction is driven by a propensity to habitual, as opposed to goal-directed, control over behaviour (Everitt, Dickinson, & Robbins, 2001).

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Effect of Drug Exposure on Outcome-Devaluation in Animals

To test the habit theory of drug dependence, animal studies have examined whether chronic drug exposure modifies performance in the outcome-devaluation procedure. The design of these studies can be broken into four types (see the Habit Research in Action box).

1. In the most compelling set of studies, animals learn that one instrumental lever press response produces drug reward (alcohol, cocaine, nicotine in different studies), and in separate training blocks, learns that another instrumental response produces food. Then, in separate test phases, each outcome is devalued by pairing it with lithium chloride-induced sickness. Finally, animals are given the opportunity to perform the instrumental response for the devalued outcome in an extinction test. Four studies using this design have found that the drug-seeking response is habitual in not being reduced by the devaluation treatment in the extinction test (Dickinson, Wood, & Smith, 2002; Loughlin, Funk, Coen, & Lê, 2017; Mangieri, Cofresí, & Gonzales, 2012; Miles, Everitt, & Dickinson, 2003). Such insensitivity to devaluation suggests that the drug-seeking response is not goal-directed (not controlled by knowledge of the current value of the outcome) but rather, is habitual, i.e. elicited automatically by the stimulus context. By contrast, the food-seeking response in the studies is shown to be reduced by devaluation, indicating that it is goal-directed in being controlled by the expected low value of the outcome and knowledge of which response produces that outcome. These four studies provide the core empirical basis for the claim that drug-seeking (in animals) is especially prone to habitual control.
2. In the second type of design, animals are chronically exposed to a drug (experimenter administered or consumed in the home cage), and then trained on single lever for food, food is then devalued, and finally the food-seeking response is tested in extinction. Eight studies have shown that in the extinction test, food-seeking is habitual in the drug exposed animals (insensitive to devaluation) and goal-directed in the non-drug-exposed animals (Corbit, Chieng, & Balleine, 2014; Corbit, Nie, & Janak, 2012; LeBlanc, Maidment, & Ostlund, 2013; Nelson & Killcross, 2006, 2013; Nordquist et al., 2007; Schmitzer-Torbert et al., 2015; Schoenbaum & Setlow, 2005); although three studies have failed to demonstrate this effect (Ripley, Borlikova, Lyons, & Stephens, 2004; Shiflett, 2012; Son, Latimer, & Keefe, 2011). These data suggest that drug exposure renders animals generally prone to habitual control of rewarded instrumental behaviour, which could conceivably play a role in dependence formation by promoting general behavioural autonomy, although how this could promote drug dependence specifically remains unclear.
3. In the third type of design, animals are trained on a single lever for the drug, and sensitivity to devaluation is tested after minimal training versus extensive training. Three studies have demonstrated that the drug-seeking response is initially goal-directed, but then becomes habitual with extensive training (Clemens, Castino, Cornish, Goodchild, & Holmes, 2014; Corbit et al., 2012; Zapata,

Minney, & Shippenberg, 2010). However, given that food-seeking also transitions from being goal-directed to habitual with training (Dickinson, Balleine, Watt, Gonzalez, & Boakes, 1995), these findings tell us nothing about the unique habit forming status of drug-seeking.

4. In the fourth type of design, animals are trained on a single lever for the drug and tested for sensitivity to devaluation following a fixed amount of training. These studies have revealed drug-seeking to be goal-directed (Hutcheson, Everitt, Robbins, & Dickinson, 2001; Olmstead, Lafond, Everitt, & Dickinson, 2001), and habitual (Corbit, Nie, & Janak, 2014). Again, these studies tell us nothing about the unique habit forming status of drug-seeking.

Criticisms of Animal Outcome-Devaluation Studies

There are two main criticisms of the animal outcome-devaluation model of habitual drug-seeking. First, habitual instrumental behaviour is only found when animals have access to a single lever in each session. By contrast, when rats have concurrent access to two levers for different rewards in each session, drug-seeking remains goal-directed (Halbout, Liu, & Ostlund, 2016), food-seeking remains goal-directed despite chronic drug exposure (Phillips & Vugler, 2011; Son et al., 2011), food-seeking remains goal-directed despite overtraining (Colwill & Rescorla, 1985; Colwill & Triola, 2002; Holland, 2004; Kosaki & Dickinson, 2010), and drug self-administration remains sensitive to shock punishment (Pelloux, Murray, & Everitt, 2015). It has been suggested that concurrent access to two responses for different rewards maintains memory for the response–outcome relationships abolishing habitual control (Klossek, Yu, & Dickinson, 2011; Kosaki & Dickinson, 2010). If one accepts that the natural environment of human drug users contains access to multiple responses for different rewards, then it must be concluded that the form of habitual control demonstrated in the animal model could not play a role in human addictive behaviour (Heather, 2017; Singer, Fadanelli, Kawa, & Robinson, 2018).

The second criticism is that habitual control in the outcome-devaluation procedure is fragile in that the sensitivity of drug-seeking (Dickinson et al., 2002; Loughlin et al., 2017; Mangieri et al., 2012; Miles et al., 2003) and food-seeking in chronically drug exposed animals (Nelson & Killcross, 2006, 2013) to outcome-devaluation is restored in reacquisition tests where instrumental response produces the devalued reinforcer. Sensitivity to devaluation may be restored in the reacquisition test either because the response can be modified by S-R learning or because animals are reminded of the response–outcome contingencies (Dickinson et al., 2002). If it is accepted that in the natural environment of human drug users instrumental responses are typically reinforced (is more comparable to the reacquisition than the extinction condition) then it must be concluded that habitual control demonstrated in the extinction test of the animal model can play little role in human addictive behaviour.

To negate the problem that habitual control is limited to extinction conditions, subsequent theories of habit and compulsivity (e.g. Everitt & Robbins, 2016) have proposed that drug-seeking may become permanently insensitive to devaluation, based on the finding that impulsive or chronically drug exposed animals are less sensitive to the suppressive effect of shock punishment on drug-seeking (Belin, Mar, Dalley, Robbins, & Everitt, 2008; Economidou, Pelloux, Robbins, Dalley, & Everitt, 2009; Pelloux et al., 2015; Pelloux, Everitt, & Dickinson, 2007; Vanderschuren & Everitt, 2004). However, persistence of punished self-administration appears to be driven by the greater reinforcement value ascribed to the drug (Bentzley, Jhou, & Aston-Jones, 2014), which was inadequately assessed by single lever self-administration procedures in the earlier studies (Ahmed, 2010). In sum, the restriction of habitual control to single lever tests, the abolition of habitual control in reinforced conditions, and the attribution of persistent punished drug-seeking to heightened drug value, weakens the claim habit or compulsion plays a role in human addiction (Becker & Greig, 2010; Bentzley et al., 2014; Heather, 2017; Markou, Chiamulera, Geyer, Tricklebank, & Steckler, 2009; Pierce, O'Brien, Kenny, & Vanderschuren, 2012).

Outcome-Devaluation Studies with Human Drug Users

Nine outcome-devaluation experiments (published in six papers) have tested whether habit is more pronounced in human drug users versus non-users, or as a function of dependence severity in the user group. In two experiments, student smokers first learned that two key press responses earned tobacco and chocolate points, respectively (Hogarth & Chase, 2011). Tobacco was devalued by smoking to satiety or health warnings (in Experiment 1 and 2 respectively), before choice between the two responses was tested in extinction. Devaluation reduced tobacco choice in the extinction test of both experiments indicating that tobacco choice was goal-directed. Crucially, there was no correlation between sensitivity to devaluation and tobacco dependence, contradicting habit theory. The third study used the same protocol but tobacco was devalued by a 1 mg dose of nicotine nasal spray (Hogarth, 2012). This devaluation treatment reduced goal-directed tobacco choice in less-dependent smokers, and primed goal-directed tobacco choice in more-dependent smokers, demonstrating different motivational effects of the 1 mg dose. Nevertheless, more-dependent smokers were demonstrably goal-directed, again contradicting habit theory. In the final experiment of this series (Hogarth, Chase, & Baess, 2012), student smokers learned that two responses earned chocolate and water points respectively, one outcome was then devalued, and choice was measured in extinction. Daily- and non-daily smokers differed markedly in dependent severity but showed no differential propensity to habit in the extinction test. These four studies contradict the prediction of habit theory that propensity to habit should be more pronounced as a function of dependence severity.

One possibility is that habit is exclusively found in drug users who are clinically dependent. This was tested in two experiments where treatment-seeking addicts learned that two responses earned food and drink points respectively, before one outcome was devalued (Hogarth, Lam-Cassettari, et al., 2018) and choice was tested in extinction. In both experiments, treatment-seeking drug users and controls were equally goal-directed, contradicting the prediction that habit would be more evident in clinically dependent users.

Only two outcome-devaluation studies suggest that habit learning is more pronounced in drug users. One study trained alcohol-dependent and control participants on an instrumental discrimination task in which a left or right response was rewarded with points depending on which 'stimulus fruit' picture was present (Sjoerds et al., 2013). When points were earned, an 'outcome fruit' picture was also presented, which was reliably associated with the left or right response. In the outcome-devaluation test, two outcome fruits were presented together, associated with the left and right response, respectively. One outcome fruit had a cross through it and participants were told to choose the response associated with the uncrossed outcome fruit, as only this response would be rewarded. Alcohol-dependent participants were less accurate in choosing the correct (rewarded) response, indicating that they had weaker knowledge of the association between the responses and the outcome fruits. However, there is a problem with interpreting this finding as evidence for propensity to habit or impaired goal-directed control (De Houwer, Tanaka, Moors, & Tibboel, 2018). Alcohol-dependent participants may have been goal-directed in that they learned which response produced points in the presence of each stimulus fruit, and simply ignored the outcome fruits that accompanied the points because they were incidental to task performance. Alcohol-dependent participants may have been more inclined to ignore the incidental outcome fruits because of general cognitive impairments or task disengagement (Stavro, Pelletier, & Potvin, 2013), rather than because they have a specific deficit in goal-directed control or propensity to habit.

The final study tested an appetitive and aversive version of the outcome-devaluation procedure in cocaine-dependent individuals versus controls (Ersche et al., 2016). The appetitive task was very similar to the task used by Sjoerds et al. (2013) described above. The key finding was that in the outcome-devaluation test, cocaine-dependent participants showed poorer accuracy, again indicating weaker knowledge of the relationships between the left and right responses and the incidental outcome stimuli. As before, this impairment could be due to cocaine-dependent participants simply ignoring the incidental outcome stimuli, while acquiring goal-directed knowledge of the response-points contingencies (De Houwer et al., 2018). More damaging still, cocaine-dependent participants showed poorer accuracy (and slower response latencies) during initial discrimination learning, which accounted for a substantial proportion of the variance in accuracy in the outcome-devaluation test. Also, cocaine-dependent participants verbally reported less knowledge of the relationships between discriminative stimuli, responses and outcome stimuli in the task. The implication is that cocaine-dependent participants' impaired performance in the outcome-devaluation test was due to general cognitive impairment or task disengagement (Potvin, Stavro, Rizkallah, & Pelletier, 2014), rather than a specific propensity for habit learning.

Habit theory was further weakened by cocaine-dependent and control participants showing comparable outcome-devaluation performance in the aversive procedure (Ersche et al., 2016). In the aversive procedure, discriminative stimuli were presented which signalled that the left or right wrist would be imminently shocked unless the foot pedal on the corresponding side was pressed to cancel the shock (cocaine-dependent participants again showed poorer discrimination accuracy). In the outcome-devaluation test, one wrist was disconnected from the shock generator and participants were told that wrist would not be shocked—the implication being that there was no need to press the foot pedal on the same side as the disconnected wrist to cancel signalled shock. The groups equally reduced foot pedal responses corresponding to the disconnected wrist, suggesting they were able to integrate the instructions into decision-making, i.e. are equally goal-directed, contradicting habit theory.

In sum, seven outcome-devaluation studies have shown that propensity to habit is not more pronounced in drug users versus controls, or as a function of dependence severity, whereas two studies have claimed evidence for weaker goal-directed knowledge in alcohol and cocaine-dependent participants. This gives a ratio of 7:2 studies against habit theory. Furthermore, the two studies which claim evidence for weaker goal-directed knowledge in drug users can be criticised for inadequately assessing the nature of users' knowledge (De Houwer et al., 2018), and may be explained by general cognitive deficits or task disengagement. The human outcome-devaluation task has provided little or no evidence for habit theory of dependence.

Two-Stage Task in Human Drug Users

The two-stage task is another procedure used to quantify the balance between goal-directed and habitual control in humans (see the Habit Research in Action box). The measure of goal-directed versus habitual control in the two-stage task correlates with sensitivity to outcome-devaluation, suggesting these tasks assess a common capacity (Gillan, Otto, Phelps, & Daw, 2015), but it remains unclear to what extent poor performance also reflects general cognitive impairments or task disengagement.

There are currently eight studies (reported in seven papers) which have used the two-stage task to compare drug users versus controls, or examine variation across dependence severity. One study found that in a large general sample obtained through online testing, greater self-reported alcohol use disorder severity was weakly associated with reduced goal-directed (model-based) control (Gillan, Kosinski, Whelan, Phelps, & Daw, 2016). Another study found a weak significant reduction goal-directed control in alcohol-dependent patients versus control participants in a one-tailed test (Sebold et al., 2014), but this difference was abolished when a group difference in cognitive speed was controlled. The third study found that methamphetamine-dependent participants were less goal-directed than control participants (Voon et al., 2015). However, alcohol-dependent participants reported in the same paper (the fourth study) had comparable goal-directed capacity to control participants. The fifth study found no association between goal-directed control and binge drinking severity in 18 year old social drinkers (Nebe et al., 2017). The sixth study found no relationship between goal-directed control and frequency of alcohol consumption in a general sample of young adults (Deserno et al., 2015). The seventh study found no reduction in goal-directed control in children of alcoholic fathers compared to control participants (Reiter, Deserno, Wilbertz, Heinze, & Schlagenhauf, 2016). Finally, the eighth study found no reduction in goal-directed control in alcohol-dependent participants compared to healthy controls (Sebold et al., 2017). In sum, the two-stage task has yielded five studies against habit theory and three studies in favour (although one favourable effect was abolished when cognitive speed was controlled), giving a ratio of 5:3 against versus for habit theory (at best). It remains unclear to what extent the other positive effects were due to general cognitive impairment or task disengagement.

Interpreting Human Evidence for Habit in Addiction: The Role of Explicit Contingency Knowledge

Human studies using the outcome-devaluation and two-stage task have collectively yielded 12 negative studies showing no greater propensity for habit in drug users or as a function of dependence severity, and five positive studies which have reported such effects, i.e. a ratio of 12:5 negative to positive findings. A key question is whether there is any obvious distinction between positive and negative studies, which accounts for their differential findings. It can't be claimed that negative studies all used concurrent choice procedures militating against habit (see section "Criticisms of Animal Outcome-Devaluation Studies"), because the five positive studies also used choice designs. It also cannot be claimed that positive studies all used clinical samples whereas negative studies used sub-clinical samples, because there are four negative studies with clinical samples (Ersche et al., 2016; Hogarth, Lam-Cassettari, et al., 2018; Voon et al., 2015) and one positive study with a general online sample (Gillan et al., 2016).

The explanation offered here is that in tasks where drug users acquire explicit contingency knowledge, they also show goal-directed/model based control, whereas in tasks where drug users do not acquire explicit contingency knowledge, they show a general deficit in task performance which is misinterpreted as evidence for a propensity to habit/model free learning. It is notable that accurate contingency knowledge was acquired by drug users in the seven outcome-devaluation studies which reported intact goal-directed control in drug users (Ersche et al., 2016; Hogarth, 2012; Hogarth et al., 2012; Hogarth & Chase, 2011; Hogarth, Lam-Cassettari, et al., 2018). In these studies, the contingencies were often simple, sometimes a small number of contingency unaware participants were excluded, and sometimes training continued until contingency knowledge was acquired. By contrast, of the two outcome-devaluation studies which claimed evidence for habit learning in drug users, one did not publish data on contingency knowledge (Sjoerds et al., 2013), and the other reported impaired explicit contingency knowledge (Ersche et al., 2016). Comparison of the two tasks reported in this final study is particularly telling (Ersche et al., 2016). In the aversive learning outcome-revaluation task where cocaine-dependent showed goal-directed control, they also showed accurate contingency knowledge. To quote: “All participants demonstrated intact awareness about the task contingences (100% accuracy in both groups)” (page 7 of the supplementary material). By contrast, in the appetitive outcome-devaluation task where the cocaine-dependent group (CUD) showed impaired goal-directed control, they also had impaired contingency knowledge. To quote: “Compared with control volunteers, CUD demonstrated significant deficits in explicit knowledge in terms of stimulus-outcome (mean: $U = 985$, $p < 0.001$), response–outcome ($U = 1250$, $p = 0.007$) and stimulus-response ($U = 1023$, $p < 0.001$) relationships” (page 6 of supplementary material). Finally, all of the two-stage studies gave participants explicit instructions about the transitional structure and reward probabilities operating in the task, but knowledge of these contingencies was not assessed at the end of the procedure, and so the relationship between contingency knowledge and model-based performance remains unknown. In conclusion, where it is possible to assess their co-occurrence, goal-directed control and explicit knowledge of task contingencies do co-occur. The implication is that excessive habit/model free learning in drug users, shown in a small number of studies, is probably due to an impairment in explicit contingency knowledge, due to general cognitive deficit or weaker motivation to engage in the task (Potvin et al., 2014; Stavro et al., 2013), which produces a general deficit in task performance (Hogarth & Duka, 2006; Mitchell, De Houwer, & Lovibond, 2009), which is misinterpreted as evidence for a specific propensity to habit learning.

Excessive Goal-Directed Drug-Seeking as an Alternative to Habit Theory

In contrast to the weak evidence for habit theory, there is substantial evidence that dependence is underpinned by excessive goal-directed drug-seeking. First, dependence severity in both sub-clinical and clinical dug users is reliably associated with greater economic demand for drugs, that is, willingness to work or pay for drugs (Bruner & Johnson, 2014; Chase, MacKillop, & Hogarth, 2013; Gray & MacKillop, 2014; MacKillop et al., 2008, 2010; MacKillop & Murphy, 2007; MacKillop & Tidey, 2011; Murphy & MacKillop, 2006; Murphy, MacKillop, Skidmore, & Pederson, 2009; Murphy, MacKillop, Tidey, Brazil, & Colby, 2011; Petry, 2001). Furthermore, economic demand for drugs prospectively predicts relapse following a cessation attempt consistent with a causal role (MacKillop, 2016; MacKillop & Murphy, 2007; Murphy et al., 2006, 2015; Murphy, Correia, Colby, & Vuchinich, 2005). Similarly, in animals, economic demand for the cocaine prospectively predicts persistent responding in extinction, cued- and drug-induced reinstatement (relapse), and insensitivity to shock punishment of self-administration (Bentzley et al., 2014). Thus, dependence is associated with greater value ascribed to the drug.

Studies measuring concurrent choice between drugs and natural rewards suggest that dependence is mediated by excessive goal-directed drug-seeking. Specifically, dependence severity in both sub-clinical and clinical drug user is reliably associated with preferential choice of the drug (Chase et al., 2013; Hardy & Hogarth, 2017; Hardy, Mitchell, Seabrooke, & Hogarth, 2017; Hogarth, 2012; Hogarth & Chase, 2011, 2012; Hogarth & Hardy, 2018; Hogarth, Hardy, Mathew, & Hitsman, 2018; Miele et al., 2018; Moeller et al., 2009, 2013). Choice of the drug in concurrent choice designs is also demonstrably goal-directed as shown by sensitivity to devaluation in an extinction test (Hogarth, 2012; Hogarth et al., 2015; Hogarth & Chase, 2011; Hogarth, Field, & Rose, 2013). In animals, preferential concurrent choice of drugs in rats is associated with greater number of neurons in the orbitofrontal cortex (OFC) that activate in preparation for that choice (Guillem & Ahmed, 2017; Guillem, Brenot, Durand, & Ahmed, 2018), and the OFC is known to play a role in encoding goal-directed outcome values in humans (Valentin, Dickinson, & O'Doherty, 2007; see: Balleine & O'Doherty, 2010; Mannella, Mirolli, & Baldassarre, 2016). Together, these data suggest that dependence is mediated by the ascription of greater value to the drug, which drives excessive goal-directed drug-seeking.

Excessive incentive learning may further promote goal-directed drug-seeking in drug users with comorbid psychiatric illness. Specifically, goal-directed drug choice is reliably increased by aversive states of withdrawal (Hogarth, Mathew, & Hitsman, 2017; Hutcheson et al., 2001) and acute negative mood (Hardy & Hogarth, 2017; Hogarth et al., 2015; Hogarth & Hardy, 2018). Individuals with depression symptoms and those who report using drugs to cope with negative affect are more sensitive to the motivational impact of withdrawal and negative mood-induced priming of goal-directed drug choice (Fucito & Juliano, 2009; Hogarth et al., 2017; Hogarth & Hardy, 2018; Hogarth, Hardy, et al., 2018). Furthermore, depression (Crum et al., 2008) and drinking to cope with negative affect (Crum et al., 2013) are both excellent prospective markers for the development of dependence. The implication of the foregoing data is that dependence is mediated by excessive goal-directed drug choice, combined with comorbid psychiatric states conferring increased sensitivity to the motivational effects of adverse states promoting further goal-directed drug choice via incentive learning (Hogarth et al., 2015; Hogarth & Hardy, 2018; Mathew, Hogarth, Leventhal, Cook, & Hitsman, 2017). Certainly, the evidence for excessive goal-directed drug-seeking driving dependence is more compelling than the evidence for habit theory.

Implications for Treatment

The studies reviewed in this chapter have indicated that human drug dependence is not reliably associated with propensity to habit, but is reliably associated with excessive goal-directed drug choice and sensitivity to adverse state triggers of goal-directed choice. If drug-seeking in dependent individuals is not a habit, then treatments designed to target habits, for example, implementation intentions (Webb, Sheeran, & Luszczynska, 2009) or avoidance training (Eberl et al., 2013), may ultimately be less effective (see also Chap. 16 in this volume). By contrast, if drug-seeking in dependent individuals is a goal-directed choice driven by the expected value of the drug, then treatments should seek to: (a) Decrease the value of the drug, for example, by health education (Kleinot & Rogers, 1982), mood/stress management (Bradizza et al., 2017; Pettinati, O'Brien, & Dundon, 2013), drug replacement medication (Mariani, Khantzian, & Levin, 2014; Stead, Perera, Mant, & Lancaster, 2008); (b) Increase the costs associated with the drug, for example, by taxation or minimum price policies (Chaloupka, Grossman, & Saffer, 2002) or prohibition (MacCoun & Reuter, 2011); (c) Increase the value of competing alternative rewards, for example, by contingency management (Higgins, Heil, & Lussier, 2004; Regier & Redish, 2015), behavioural activation (Ross et al., 2016) or community-reinforcement (Meyers, Roozen, & Smith, 2011); and (d) Decrease the costs associated with the alternative competing rewards, for example, by prescription access to exercise facilities (Sanchez, Bully, Martinez, & Grandes, 2015) or funding access to work (Silverman et al., 2007). Ideally, treatments should target the value and costs ascribed to both drugs and natural rewards simultaneously, to maximise the impact on goal-directed drug choice.

Conclusion

Animal studies have suggested that drug-seeking and natural reward-seeking is more prone to habitual control following chronic drug exposure. However, these effects are restricted to single choice situations where there is no direct experience of the devalued outcome (extinction), so these effects are unlikely to operate in complex human decision-making environments (Heather, 2017). Twelve human outcome-devaluation and two-stage have shown that habit learning is not more pronounced in drug users, or as a function of dependence severity, whereas five studies have reported these effects. These five human studies favouring habit theory may be trivially explained by general cognitive deficits/task disengagement giving rise to weaker explicit contingency knowledge and hence poorer general task performance. By contrast, there is compelling evidence that human drug dependence is driven by excessive goal-directed drug-seeking and that psychiatric comorbidity confers greater sensitivity to acute adverse states triggering further goal-directed drug-seeking through incentive learning. Treatments should focus on the decision-making processes involved in the weighing the relative value and costs of drugs versus competing natural goals.

Habit Research in Action

The outcome-devaluation task—In the outcome-devaluation task, subjects learn that two responses (R1 and R1) earn different rewarding outcomes (O1 and O2). One outcome is then devalued by pairing it with sickness or consumption to satiety. Finally, choice between the two responses is tested in extinction (no rewards are provided). A reduction in choice of the response that earned the devalued outcome must be mediated by an expectation of the current low value of that outcome (i.e. must be goal-directed). The test is conducted in extinction because if the response produced the devalued outcome, the propensity to make this response could be reduced by a weakening of the habitual stimulus-response association controlling the response.

The two-stage task—At the start of each trial, the same first-stage pair of stimuli is always presented. When participants select one stimulus from this first-stage pair, a 'common' second-stage stimulus pair is produced on 70% of occasions, whereas a different 'rare' second-stage pair is produced on 30% of occasions. By contrast, if the other stimulus from the first-stage pair is selected, the common and rare second-stage pairs are reversed. Participants are informed about the transitional structure between choices made between stimuli at the first stage, and the production of the rare and common second-stage pairs. Upon production of a second-stage pair, participants select one stimulus, and this yields money reward with a probability between 0.25 and 0.75, which varies slowly over trials, and independently of the other second stage stimuli. Thus, on any given trial, participants can maximise payoff by learning that selection of a first stage stimulus reliably produces the common and rare second stage pairs with different probabilities, from which the second-stage stimulus can be selected that is most likely to pay off based on recent experience of which second stage stimuli are being rewarded. Participants who are goal-directed ('model-based') can be distinguished from those who are habitual ('model-free') on the basis of their choices following trials in which a rare transition was rewarded. Specifically, on trials where choice of a first-stage stimulus produced the rare second-stage pair, and a stimulus selected from this second-stage pair was reinforced, participants face an interesting conundrum when choosing a first-stage stimulus in the next trial. If participants are goal-directed (model-based) they will choose the other first-stage stimulus than the one they chose previously, to give a 70% chance of producing the same second-stage pair as the previous trial, and thereby select the second-stage stimulus that was just rewarded. By contrast, if participants are habitual (model-free), they will choose the same first-stage stimulus as they chose on the previous trial because that previous trial was reinforced, even though this choice gives only a 30% chance of producing the same second-stage pair as the previous trial, from which the previously rewarded stimulus could be selected. The task therefore measures whether participants are using knowledge of the rare and common transitional structure of the task to chase the second-stage stimuli that are currently paying off.

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References

Ahmed, S. H. (2010). Validation crisis in animal models of drug addiction: Beyond non-disordered drug use toward drug addiction. *Neuroscience and Biobehavioral Reviews, 35*, 172–184.

Balleine, B. W., & O'Doherty, J. P. (2010). Human and rodent homologies in action control: Corticostriatal determinants of goal-directed and habitual action. *Neuropsychopharmacology, 35*, 48–69.

Becker, R. E., & Greig, N. H. (2010). Lost in translation: Neuropsychiatric drug development. *Science Translational Medicine, 2*, 61rv66.

Belin, D., Mar, A. C., Dalley, J. W., Robbins, T. W., & Everitt, B. J. (2008). High impulsivity predicts the switch to compulsive cocaine-taking. *Science, 320*, 1352–1355.

Bentzley, B. S., Jhou, T. C., & Aston-Jones, G. (2014). Economic demand predicts addiction-like behavior and therapeutic efficacy of oxytocin in the rat. *Proceedings of the National Academy of Sciences of the United States of America, 111*, 11822–11827.

Bradizza, C. M., Stasiewicz, P. R., Zhuo, Y., Ruszczyk, M., Maisto, S. A., Lucke, J. F., et al. (2017). Smoking cessation for pregnant smokers: Development and pilot test of an emotion regulation treatment supplement to standard smoking cessation for negative affect smokers. *Nicotine and Tobacco Research, 19*, 578–584.

Bruner, N. R., & Johnson, M. W. (2014). Demand curves for hypothetical cocaine in cocaine-dependent individuals. *Psychopharmacology (Berl), 231*, 889–897.

Chaloupka, F. J., Grossman, M., & Saffer, H. (2002). The effects of price on alcohol consumption and alcohol-related problems. *Alcohol Research & Health, 26*, 22–34.

Chase, H. W., MacKillop, J., & Hogarth, L. (2013). Isolating behavioural economic indices of demand in relation to nicotine dependence. *Psychopharmacology, 226*, 371–380.

Clemens, K. J., Castino, M. R., Cornish, J. L., Goodchild, A. K., & Holmes, N. M. (2014). Behavioral and neural substrates of habit formation in rats intravenously self-administering nicotine. *Neuropsychopharmacology, 39*, 2584–2593.

Colwill, R. M., & Rescorla, R. A. (1985). Instrumental responding remains sensitive to reinforcer devaluation after extensive training. *Journal of Experimental Psychology Animal Behavior Processes, 11*, 520–536.

Colwill, R. M., & Triola, S. M. (2002). Instrumental responding remains under the control of the consequent outcome after extended training. *Behavioural Processes, 57*, 51–64.

Corbit, L. H., Chieng, B. C., & Balleine, B. W. (2014). Effects of repeated cocaine exposure on habit learning and reversal by N-acetylcysteine. *Neuropsychopharmacology, 39*, 1893–1901.

Corbit, L. H., Nie, H., & Janak, P. H. (2012). Habitual alcohol seeking: Time course and the contribution of subregions of the dorsal striatum. *Biological Psychiatry, 72*, 389–395.

Corbit, L. H., Nie, H., & Janak, P. H. (2014). Habitual responding for alcohol depends upon both AMPA and D2 receptor signaling in the dorsolateral striatum. *Frontiers in Behavioral Neuroscience, 8*, 301.

Crum, R. M., Green, K. M., Storr, C. L., Chan, Y. F., Ialongo, N., Stuart, E. A., et al. (2008). Depressed mood in childhood and subsequent alcohol use through adolescence and young adulthood. *Archives of General Psychiatry, 65*, 702–712.

Crum, R. M., Mojtabai, R., Lazareck, S., Bolton, J. M., Robinson, J., Sareen, J., et al. (2013). A prospective assessment of reports of drinking to self-medicate mood symptoms with the incidence and persistence of alcohol dependence. *JAMA Psychiatry, 70*, 718–726.

De Houwer, J., Tanaka, A., Moors, A., & Tibboel, H. (2018). Kicking the habit: Why evidence for habits in humans might be overestimated. *Motivation Science, 4*, 50–59.

Deserno, L., Wilbertz, T., Reiter, A., Horstmann, A., Neumann, J., Villringer, A., et al. (2015). Lateral prefrontal model-based signatures are reduced in healthy individuals with high trait impulsivity. *Translational Psychiatry, 5*, e659.

Dickinson, A. (1997). Bolles's psychological syllogism. In M. Bouton & M. Fanselow (Eds.), *Learning, motivation and cognition* (pp. 345–367). Washington D.C.: American Psychological Association.

Dickinson, A., Balleine, B. W., Watt, A., Gonzalez, F., & Boakes, R. A. (1995). Motivational control after extended instrumental training. *Animal Learning & Behavior, 23*, 197–206.

Dickinson, A., Wood, N., & Smith, J. W. (2002). Alcohol seeking by rats: Action or habit? *The Quarterly Journal of Experimental Psychology B, 55*, 331–348.

Eberl, C., Wiers, R. W., Pawelczack, S., Rinck, M., Becker, E. S., & Lindenmeyer, J. (2013). Approach bias modification in alcohol dependence: Do clinical effects replicate and for whom does it work best? *Developmental Cognitive Neuroscience, 4*, 38–51.

Economidou, D., Pelloux, Y., Robbins, T. W., Dalley, J. W., & Everitt, B. J. (2009). High impulsivity predicts relapse to cocaine-seeking after punishment-induced abstinence. *Biological Psychiatry, 65*, 851–856.

Ersche, K. D., Gillan, C. M., Jones, P. S., Williams, G. B., Ward, L. H. E., Luijten, M., et al. (2016). Carrots and sticks fail to change behavior in cocaine addiction. *Science, 352*, 1468–1471.

Everitt, B. J., Dickinson, A., & Robbins, T. W. (2001). The neuropsychological basis of addictive behaviour. *Brain Research Reviews, 36*, 129–138.

Everitt, B. J., & Robbins, T. W. (2016). Drug addiction: Updating actions to habits to compulsions ten years on. *Annual Review of Psychology, 67*, 23–50.

Fucito, L. M., & Juliano, L. M. (2009). Depression moderates smoking behavior in response to a sad mood induction. *Psychology of Addictive Behaviors, 23*, 546–551.

Gillan, C. M., Kosinski, M., Whelan, R., Phelps, E. A., & Daw, N. D. (2016). Characterizing a psychiatric symptom dimension related to deficits in goal-directed control. *eLife, 5*, e11305.

Gillan, C. M., Otto, A. R., Phelps, E. A., & Daw, N. D. (2015). Model-based learning protects against forming habits. *Cognitive, Affective, and Behavioral Neuroscience, 15*, 523–536.

Gray, J. C., & MacKillop, J. (2014). Interrelationships among individual differences in alcohol demand, impulsivity, and alcohol misuse. *Psychology of Addictive Behaviors, 28*, 282–287.

Guillem, K., & Ahmed, S. H. (2017). Preference for cocaine is represented in the orbitofrontal cortex by an increased proportion of cocaine use-coding neurons. *Cerebral Cortex, 28*, 819–832.

Guillem, K., Brenot, V., Durand, A., & Ahmed, S. H. (2018). Neuronal representation of individual heroin choices in the orbitofrontal cortex. *Addiction Biology, 23*(3), 880–888.

Halbout, B., Liu, A. T., & Ostlund, S. B. (2016). A closer look at the effects of repeated cocaine exposure on adaptive decision-making under conditions that promote goal-directed control. *Frontiers in Psychiatry, 7*, 44.

Hardy, L., & Hogarth, L. (2017). A novel concurrent pictorial choice model of mood-induced relapse in hazardous drinkers. *Experimental and Clinical Psychopharmacology, 25*, 448–455.

Hardy, L., Mitchell, C., Seabrooke, T., & Hogarth, L. (2017). Drug cue reactivity involves hierarchical instrumental learning: Evidence from a biconditional Pavlovian to instrumental transfer task. *Psychopharmacology, 234*, 1977–1984.

Heather, N. (2017). Is the concept of compulsion useful in the explanation or description of addictive behaviour and experience? *Addictive Behaviors Reports, 6*, 15–38.

Heyes, C., & Dickinson, A. (1990). The intentionality of animal action. *Mind and Language, 5*, 87–104.

Higgins, S. T., Heil, S. H., & Lussier, J. P. (2004). Clinical implications of reinforcement as a determinant of substance use disorders. *Annual Review of Psychology, 55*, 431–461.

Hogarth, L. (2012). Goal-directed and transfer-cue-elicited drug-seeking are dissociated by pharmacotherapy: Evidence for independent additive controllers. *Journal of Experimental Psychology: Animal Behavior Processes, 38*, 266–278.

Hogarth, L., & Chase, H. W. (2011). Parallel goal-directed and habitual control of human drug-seeking: Implications for dependence vulnerability. *Journal of Experimental Psychology: Animal Behavior Processes, 37*, 261–276.

Hogarth, L., & Chase, H. W. (2012). Evaluating psychological markers for human nicotine dependence: Tobacco choice, extinction, and Pavlovian-to-instrumental transfer. *Experimental and Clinical Psychopharmacology, 20*, 213–224.

Hogarth, L., Chase, H. W., & Baess, K. (2012). Impaired goal-directed behavioural control in human impulsivity. *The Quarterly Journal of Experimental Psychology, 65*, 305–316.

Hogarth, L., & Duka, T. (2006). Human nicotine conditioning requires explicit contingency knowledge: Is addictive behaviour cognitively mediated? *Psychopharmacology, 184*, 553–566.

Hogarth, L., Field, M., & Rose, A. K. (2013). Phasic transition from goal-directed to habitual control over drug-seeking produced by conflicting reinforcer expectancy. *Addiction Biology, 18*, 88–97.

Hogarth, L., & Hardy, L. (2018). Depressive statements prime goal-directed alcohol-seeking in individuals who report drinking to cope with negative affect. *Psychopharmacology, 235*, 269–279.

Hogarth, L., Hardy, L., Mathew, A. R., & Hitsman, B. (2018). Negative mood-induced alcohol-seeking is greater in young adults who report depression symptoms, drinking to cope, and subjective reactivity. *Experimental and Clinical Psychopharmacology, 26*, 138–146.

Hogarth, L., He, Z., Chase, H. W., Wills, A. J., Troisi II, J., Leventhal, A. M., et al. (2015). Negative mood reverses devaluation of goal-directed drug-seeking favouring an incentive learning account of drug dependence. *Psychopharmacology, 232*, 3235–3247.

Hogarth, L., Lam-Cassettari, C., Pacitti, H., Currah, T., Mahlberg, J., Hartley, L., & Moustafa, A. (2018). Intact goal-directed control in treatment-seeking drug users indexed by outcome-devaluation and Pavlovian to instrumental transfer: Critique of habit theory. *The European Journal of Neuroscience* (in press).

Hogarth, L., Mathew, A. R., & Hitsman, B. (2017). Current major depression is associated with greater sensitivity to the motivational effect of both negative mood induction and abstinence on tobacco-seeking behavior. *Drug and Alcohol Dependence, 176*, 1–6.

Holland, P. C. (2004). Relations between Pavlovian-instrumental transfer and reinforcer devaluation. *Journal of Experimental Psychology Animal Behavior Processes, 30*, 258–258.

Hutcheson, D. M., Everitt, B. J., Robbins, T. W., & Dickinson, A. (2001). The role of withdrawal in heroin addiction: Enhances reward or promotes avoidance? *Nature Neuroscience, 4*, 943–947.

Kleinot, M. C., & Rogers, R. W. (1982). Identifying effective components of alcohol misuse prevention programs. *Journal of Studies on Alcohol, 43*, 802–811.

Klossek, U. H., Yu, S., & Dickinson, A. (2011). Choice and goal-directed behavior in preschool children. *Learning & Behavior, 39*, 350–357.

Kosaki, Y., & Dickinson, A. (2010). Choice and contingency in the development of behavioral autonomy during instrumental conditioning. *Journal of Experimental Psychology: Animal Behavior Processes, 36*, 334–342.

LeBlanc, K. H., Maidment, N. T., & Ostlund, S. B. (2013). Repeated cocaine exposure facilitates the expression of incentive motivation and induces habitual control in rats. *PLoS One, 8*, e61355.

Loughlin, A., Funk, D., Coen, K., & Lê, A. D. (2017). Habitual nicotine-seeking in rats following limited training. *Psychopharmacology, 234*(17), 2619–2629.

MacCoun, R. J., & Reuter, P. (2011). Assessing drug prohibition and its alternatives: A guide for agnostics. *Annual Review of Law and Social Science, 7*, 61–78.

MacKillop, J. (2016). The behavioral economics and neuroeconomics of alcohol use disorders. *Alcoholism: Clinical and Experimental Research, 40*, 672–685.

MacKillop, J., Miranda, R., Monti, P. M., Ray, L. A., Murphy, J. G., Rohsenow, D. J., et al. (2010). Alcohol demand, delayed reward discounting, and craving in relation to drinking and alcohol use disorders. *Journal of Abnormal Psychology, 119*, 106–114.

MacKillop, J., & Murphy, J. G. (2007). A behavioral economic measure of demand for alcohol predicts brief intervention outcomes. *Drug and Alcohol Dependence, 89*, 227–233.

MacKillop, J., Murphy, J. G., Ray, L. A., Eisenberg, D. T. A., Lisman, S. A., Lum, J. K., et al. (2008). Further validation of a cigarette purchase task for assessing the relative reinforcing efficacy of nicotine in college smokers. *Experimental and Clinical Psychopharmacology, 16*, 57–65.

MacKillop, J., & Tidey, J. W. (2011). Cigarette demand and delayed reward discounting in nicotine-dependent individuals with schizophrenia and controls: An initial study. *Psychopharmacology (Berl), 216*, 91–99.

Mangieri, R. A., Cofresí, R. U., & Gonzales, R. A. (2012). Ethanol seeking by Long Evans rats is not always a goal-directed behavior. *PLoS One, 7*, e42886.

Mannella, F., Mirolli, M., & Baldassarre, G. (2016). Goal-directed behavior and instrumental devaluation: A neural system-level computational model. *Frontiers in Behavioral Neuroscience, 10*, 181.

Mariani, J. J., Khantzian, E. J., & Levin, F. R. (2014). The self-medication hypothesis and psychostimulant treatment of cocaine dependence: An update. *The American Journal on Addictions, 23*, 189–193.

Markou, A., Chiamulera, C., Geyer, M. A., Tricklebank, M., & Steckler, T. (2009). Removing obstacles in neuroscience drug discovery: The future path for animal models. *Neuropsychopharmacology, 34*, 74–89.

Mathew, A. R., Hogarth, L., Leventhal, A. M., Cook, J. W., & Hitsman, B. (2017). Cigarette smoking and depression comorbidity: Systematic review and proposed theoretical model. *Addiction, 112*, 401–412.

Meyers, R. J., Roozen, H. G., & Smith, J. E. (2011). The community reinforcement approach: An update of the evidence. *Alcohol Research & Health, 33*, 380–388.

Miele, A., Thompson, M., Jao, N. C., Kalhan, R., Leone, F., Hogarth, L., et al. (2018). Cancer patients enrolled in a smoking cessation clinical trial: Characteristics and correlates of smoking rate and nicotine dependence. *Journal of Addiction, 2018*, 7.

Miles, F. J., Everitt, B. J., & Dickinson, A. (2003). Oral cocaine seeking by rats: Action or habit? *Behavioral Neuroscience, 117*, 927–938.

Mitchell, C. J., De Houwer, J., & Lovibond, P. F. (2009). The propositional nature of human associative learning. *The Behavioral and Brain Sciences, 32*, 183–198.

Moeller, S. J., Beebe-Wang, N., Woicik, P. A., Konova, A. B., Maloney, T., & Goldstein, R. Z. (2013). Choice to view cocaine images predicts concurrent and prospective drug use in cocaine addiction. *Drug and Alcohol Dependence, 130*, 178–185.

Moeller, S. J., Maloney, T., Parvaz, M. A., Dunning, J. P., Alia-Klein, N., Woicik, P. A., et al. (2009). Enhanced choice for viewing cocaine pictures in cocaine addiction. *Biological Psychiatry, 66*, 169–176.

Murphy, J. G., Barnett, N. P., Colby, S. M., Correia, C. J., Mackillop, J., & Vuchinich, R. E. (2006). Relative reinforcing value of alcohol predicts response to a brief intervention. *Alcoholism: Clinical and Experimental Research, 30*, 250A–250A.

Murphy, J. G., Correia, C. J., Colby, S. M., & Vuchinich, R. E. (2005). Using behavioral theories of choice to predict drinking outcomes following a brief intervention. *Experimental and Clinical Psychopharmacology, 13*, 93–101.

Murphy, J. G., Dennhardt, A. A., Yurasek, A. M., Skidmore, J. R., Martens, M. P., MacKillop, J., et al. (2015). Behavioral economic predictors of brief alcohol intervention outcomes. *Journal of Consulting and Clinical Psychology, 83*, 1033–1043.

Murphy, J. G., & MacKillop, J. (2006). Relative reinforcing efficacy of alcohol among college student drinkers. *Experimental and Clinical Psychopharmacology, 14*, 219–227.

Murphy, J. G., MacKillop, J., Skidmore, J. R., & Pederson, A. A. (2009). Reliability and validity of a demand curve measure of alcohol reinforcement. *Experimental and Clinical Psychopharmacology, 17*, 396–404.

Murphy, J. G., MacKillop, J., Tidey, J. W., Brazil, L. A., & Colby, S. M. (2011). Validity of a demand curve measure of nicotine reinforcement with adolescent smokers. *Drug and Alcohol Dependence, 113*, 207–214.

Nebe, S., Kroemer, N. B., Schad, D. J., Bernhardt, N., Sebold, M., Müller, D. K., et al. (2017). No association of goal-directed and habitual control with alcohol consumption in young adults. *Addiction Biology, 23*, 379–393.

Nelson, A., & Killcross, S. (2006). Amphetamine exposure enhances habit formation. *The Journal of Neuroscience, 26*, 3805–3812.

Nelson, A. J. D., & Killcross, S. (2013). Accelerated habit formation following amphetamine exposure is reversed by D1, but enhanced by D2, receptor antagonists. *Frontiers in Neuroscience, 7*, 76.

Nordquist, R. E., Voorn, P., Malsen, J., Joosten, R., Pennartz, C. M. A., & Vanderschuren, L. (2007). Augmented reinforcer value and accelerated habit formation after repeated amphetamine treatment. *European Neuropsychopharmacology, 17*, 532–540.

Olmstead, M. C., Lafond, M. V., Everitt, B. J., & Dickinson, A. (2001). Cocaine seeking by rats is a goal-directed action. *Behavioral Neuroscience, 115*, 394–402.

Pelloux, Y., Everitt, B. J., & Dickinson, A. (2007). Compulsive drug seeking by rats under punishment: Effects of drug taking history. *Psychopharmacology, 194*, 127–137.

Pelloux, Y., Murray, J. E., & Everitt, B. J. (2015). Differential vulnerability to the punishment of cocaine related behaviours: Effects of locus of punishment, cocaine taking history and alternative reinforcer availability. *Psychopharmacology, 232*, 125–134.

Petry, N. M. (2001). A behavioral economic analysis of polydrug abuse in alcoholics: Asymmetrical substitution of alcohol and cocaine. *Drug and Alcohol Dependence, 62*, 31–39.

Pettinati, H. M., O'Brien, C. P., & Dundon, W. D. (2013). Current status of co-occurring mood and substance use disorders: A new therapeutic target. *The American Journal of Psychiatry, 170*, 23–30.

Phillips, G. D., & Vugler, A. (2011). Effects of sensitization on the detection of an instrumental contingency. *Pharmacology, Biochemistry, and Behavior, 100*, 48–58.

Pierce, R. C., O'Brien, C. P., Kenny, P. J., & Vanderschuren, L. J. M. J. (2012). Rational development of addiction pharmacotherapies: Successes, failures, and prospects. *Cold Spring Harbor Perspectives in Medicine, 2*, a012880.

Potvin, S., Stavro, K., Rizkallah, E., & Pelletier, J. (2014). Cocaine and cognition: A systematic quantitative review. *Journal of Addiction Medicine, 8*, 368–376.

Regier, P. S., & Redish, A. D. (2015). Contingency management and deliberative decision-making processes. *Frontiers in Psychiatry, 6*, 76.

Reiter, A. M. F., Deserno, L., Wilbertz, T., Heinze, H.-J., & Schlagenhauf, F. (2016). Risk factors for addiction and their association with model-based behavioral control. *Frontiers in Behavioral Neuroscience, 10*, 26.

Ripley, T. L., Borlikova, G., Lyons, S., & Stephens, D. N. (2004). Selective deficits in appetitive conditioning as a consequence of ethanol withdrawal. *The European Journal of Neuroscience, 19*, 415–425.

Ross, J., Teesson, M., Lejuez, C., Mills, K., Kaye, S., Brady, K., et al. (2016). The efficacy of behavioural activation treatment for co-occurring depression and substance use disorder (the activate study): A randomized controlled trial. *BMC Psychiatry, 16*, 221.

Sanchez, A., Bully, P., Martinez, C., & Grandes, G. (2015). Effectiveness of physical activity promotion interventions in primary care: A review of reviews. *Preventive Medicine, 76*, S56–S67.

Schmitzer-Torbert, N., Apostolidis, S., Amoa, R., O'Rear, C., Kaster, M., Stowers, J., et al. (2015). Post-training cocaine administration facilitates habit learning and requires the infralimbic cortex and dorsolateral striatum. *Neurobiology of Learning and Memory, 118*, 105–112.

Schoenbaum, G., & Setlow, B. (2005). Cocaine makes actions insensitive to outcomes but not extinction: Implications for altered orbitofrontal-amygdalar function. *Cerebral Cortex, 15*, 1162–1169.

Sebold, M., Deserno, L., Nebe, S., Schad, D. J., Garbusow, M., Hagele, C., et al. (2014). Model-based and model-free decisions in alcohol dependence. *Neuropsychobiology, 70*, 122–131.

Sebold, M., Nebe, S., Garbusow, M., Guggenmos, M., Schad, D. J., Beck, A., et al. (2017). When habits are dangerous: Alcohol expectancies and habitual decision making predict relapse in alcohol dependence. *Biological Psychiatry, 82*, 847–856.

Shiflett, M. W. (2012). The effects of amphetamine exposure on outcome-selective Pavlovian-instrumental transfer in rats. *Psychopharmacology, 223*, 361–370.

Silverman, K., Wong, C. J., Needham, M., Diemer, K. N., Knealing, T., Crone-Todd, D., et al. (2007). A randomized trial of employment-based reinforcement of cocaine abstinence in injection drug users. *Journal of Applied Behavior Analysis, 40*, 387–410.

Singer, B. F., Fadanelli, M., Kawa, A. B., & Robinson, T. E. (2018). Are cocaine-seeking "habits" necessary for the development of addiction-like behavior in rats? *The Journal of Neuroscience, 38*, 60.

Sjoerds, Z., de Wit, S., van den Brink, W., Robbins, T. W., Beekman, A. T., Penninx, B. W., et al. (2013). Behavioral and neuroimaging evidence for overreliance on habit learning in alcohol-dependent patients. *Translational Psychiatry, 3*, e337.

Son, J.-H., Latimer, C., & Keefe, K. A. (2011). Impaired formation of stimulus–response, but not action–outcome, associations in rats with methamphetamine-induced neurotoxicity. *Neuropsychopharmacology, 36*, 2441–2451.

Stavro, K., Pelletier, J., & Potvin, S. (2013). Widespread and sustained cognitive deficits in alcoholism: A meta-analysis. *Addiction Biology, 18*, 203–213.

Stead, L. F., Perera, R., Mant, D., & Lancaster, T. (2008). Nicotine replacement therapy for smoking cessation (Review). *Cochrane Database of Systematic Reviews, 1*, CD000146.

Valentin, V., Dickinson, A., & O'Doherty, J. P. (2007). Determining the neural substrates of goal-directed learning in the human brain. *The Journal of Neuroscience, 27*, 4019–4026.

Vanderschuren, L. J. M. J., & Everitt, B. J. (2004). Drug seeking becomes compulsive after prolonged cocaine self-administration. *Science, 305*, 1017–1019.

Voon, V., Derbyshire, K., Rück, C., Irvine, M. A., Worbe, Y., Enander, J., et al. (2015). Disorders of compulsivity: A common bias towards learning habits. *Molecular Psychiatry, 20*, 345–352.

Webb, T. L., Sheeran, P., & Luszczynska, A. (2009). Planning to break unwanted habits: Habit strength moderates implementation intention effects on behaviour change. *The British Journal of Social Psychology, 48*, 507–523.

Zapata, A., Minney, V. L., & Shippenberg, T. S. (2010). Shift from goal-directed to habitual cocaine seeking after prolonged experience in rats. *The Journal of Neuroscience, 30*, 15457–15463.

Chapter 19
Habits and Autism: Restricted, Repetitive Patterns of Behaviour and Thinking in Autism

Ailsa Russell and Mark Brosnan

Leo Kanner, a child psychiatrist among the first to describe autism, noted in his observations of autistic children in 1973 that: 'they had in common a combination of extreme aloneness from the beginning of life and an anxiously obsessive desire for the preservation of sameness. They were described by their parents as "living in a world of their own"; they were little routine addicts, living in a world in which nobody other than themselves was allowed to make any changes so far as their daily lives were concerned'.

Autism (also called Autism Spectrum Disorder, ASD, or Asperger syndrome) is a neurodevelopmental condition affecting around 1–2% of the population, and is present from the early years of life and affecting an individual across the lifespan. Autism is a pervasive neurodevelopmental disorder characterised by impairments in two domains: (1) Social communication and interaction; and (2) Restricted, repetitive patterns of behaviour, interests or activities (American Psychiatric Association (APA), 2013). It has been included in modern classification systems for more than 40 years (since DSM-III APA, 1987) and an expanding field of research has sought to understand this enigmatic condition. Although there are two clinical domains that characterise autism, less than 10% of research has taken the restricted, repetitive patterns of behaviour, interests or activities domain as its focus (Kasari & Lawton, 2010), despite carers and professionals describing this as the most difficult set of symptoms to manage (Bishop et al., 2007; Lecavalier, Leone, & Wiltz, 2006; South, Ozonoff, & McMahon, 2005). One reason for the relative paucity of research into the behavioural and conceptual phenomena encompassed by the restricted, repetitive patterns of behaviour, interests and activities domain is the absence of a theoretical framework to best understand their function and mechanisms. Extending the theoretical frameworks and empirical findings from research into behavioural and

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mental habits offers an exciting opportunity to gain insights into the restricted, repetitive patterns of behaviour, interests and activities in autism. The present chapter will consider the parallels between behavioural and mental habits with the restricted, repetitive patterns of behaviour, interests and activities which are a defining feature of autism. Firstly we will summarise what is known about the restricted, repetitive patterns of behaviour, interests and activities domain in autism (for a detailed review see Leekam, Prior, & Ulkarevic, 2011). We discuss 'higher order', compared to 'lower order', repetitive behaviours and how they are measured. Repetitive behaviours are then considered within their typical developmental trajectory, focussing upon what their functions may be. Should repetitive behaviour become problematic, or pathological, we then consider interventions in addition to potential theoretical accounts, including the Executive Functioning and Dual Process theories of autism. Finally, we explore the automaticity that is argued to be a central component of habits (in addition to repetition) and the extent to which 'mental habits' may facilitate a better understanding of 'higher-order' repetitive behaviours in autism.

Classification and Taxonomy

Repetitive behaviour (RB) in the context of autism is a descriptive term used to denote behaviour which is repeated in an invariant manner, is topographically consistent, and appears functionless in that its meaning is not immediately clear to the observer (Turner, 1999). The term encompasses a wide range of behavioural phenomena from stereotyped motor behaviour such as rocking or self-biting to adherence to a complex sequence of routines to a preoccupation with, and difficulty shifting, a pattern of thinking or belief system. Turner proposed two main categories or sub-types of RB, 'lower order' referring to stereotypies and sensory-motor behaviours and 'higher order', denoting repetition at a conceptual level such as a preference for routine. The Diagnostic and Statistical Manual-5th Edition text revision (DSM-V, APA, 2013) requires that two of four categories or sub-divisions of restricted, repetitive patterns of behaviour, interests and activities are evidenced for this part of the diagnostic threshold for autism spectrum disorders (in addition to social communication deficits): (i) stereotyped motor movements, use of objects or speech, (ii) insistence on sameness, inflexible adherence to routines or ritualized patterns of verbal or nonverbal behaviour, (iii) highly restricted, fixated interests that are abnormal in intensity or focus and (iv) hyper- or hypo- reactivity to sensory input or unusual interests in sensory aspects of the environment. The sensory-motor aspects identified in the DSM-V (i) and (iv) criteria map onto Turner's lower-order category of repetitive behaviour, whilst the conceptual aspects identified in the DSM-V (ii) and (iii) criteria map onto Turners higher-order category of repetitive behaviour. For the remainder of this chapter we will use the term 'repetitive behaviours' to refer to the full range of restricted, repetitive patterns of behaviour, interests and activities characteristic of autism. The term 'lower order' will be used to refer to sensory-motor repetitive behaviours such as repetitive finger movements or stereotyped touching of preferred textures, and 'higher order' will be used to refer to behaviours reflecting conceptual repetition such as routinized activities or pursuit of intensely focused and circumscribed interests.

This lower-order and higher-order categorization of repetitive behaviours broadly corresponds to the sub-types of restricted repetitive behaviours enquired about in the most widely used diagnostic tool—the Autism Diagnostic Interview (ADI-R) (Lord, Rutter, & Le Couteur, 1994). A factor analytic study of the repetitive behaviour items on the ADI-R (Cuccaro, Shao, Grubber et al., 2003) established two distinct item groupings or factors. Factor I was termed repetitive sensory-motor behaviours (commensurate with lower-order repetitive behaviours) and Factor 2 was termed a resistance to change/insistence on sameness (commensurate with higher-order repetitive behaviours). Five items loaded onto Factor I: *Hand and finger mannerisms, unusual sensory interests, repetitive use of objects or parts of objects, Other complex mannerisms or stereotyped body movements; Rocking.* Three items loaded onto Factor II: *Difficulties with minor changes in routine or personal environment, Resistance to trivial changes in the environment; Compulsions/Rituals.* In the Cuccaro et al. (2003) study of 207 children with autism, the lower-order and higher-order factors were not found to be correlated, leading the authors to conclude that they may represent relatively independent constructs (see also Harrop et al., 2014). The behavioural phenomena encompassed by Factor 1 (lower order) were negatively associated with adaptive functioning, suggesting that lower-order repetitive behaviours may be an index of general developmental delay. Lower-order repetitions have been found to occur as frequently in children with general developmental delay (Mooney, Gray, & Tonge, 2006; Richler, Bishop, Kleinke et al., 2007) and children with a number of genetic conditions (Moss et al., 2009) as children with autism. Thus lower-order repetitions are not autism-specific and are attributable to developmental delay, intellectual disability and impaired language issues. Higher-order repetitions, on the other hand, are thought to be autism-specific.

Leekam, Prior, et al. (2011) review the methodological issues raised by this two factor classification. Importantly they highlight the potential for bi-directional relationships between lower-order and higher-order RBs. For example, a challenge to a higher-order insistence on sameness, may result in a lower-order rocking to and fro. In addition, repetitive verbal behaviour is not well dealt with by this two factor classification. Sometimes labelled 'high level verbal stereotypies', and frequently in the form of repetitive questions, these can be sophisticated in content and from the observer's perspective, seemingly used strategically in social communicative situations. This introduces additional issues reflected by the debate in the literature about the independence of the social communication and repetitive behaviour domains in autism. Genetic studies situate some clear blue water between the traits in population-based studies (Ronald et al., 2006), which has led to the question 'Is it time to give up on a single explanation of autism?' (Happé et al., 2006). Many theoretical accounts of autism have either focused upon the deficits in social communication OR the patterns of repetitive behaviour (see theory section below). However, clinical epidemiological studies of autistic people are less confident, and the two domains of impairments, separable in measurement terms, are useful as a means of conceptualizing aspects which contribute to the 'autistic whole'. Furthermore, the neurocognitive differences in autism present researchers with methodological issues in either eliciting first-person phenomenological accounts, or clearly delineating and isolating specified theoretical constructs in measurement methods.

Measurement of Higher-Order and Lower-Order Repetitive Behaviours

The heterogeneity of repetitive phenomena in autism presents complexities in terms of developing well standardized measures that can be used across cultures and studies. The majority of studies have used parental/informant reports as a basis for measurement with either broad categories of behaviour and example items employed as a structure, or questionnaires where behavioural phenomena are operationalised in terms of the parts of the body emphasized in the movements. Instruments which have been developed for use in research include the repetitive behaviours domain of the Autism Diagnostic Interview (ADI-R) (Lord, Rutter, & Le Couteur, 1994); the Childhood Routines Inventory (CRI; Evans et al., 1997); the Compulsive Behaviours Symptom Checklist of the Child version of the Yale Brown Obsessive Compulsive Scale (C-YBOCS), the Sameness Questionnaire (Prior & Macmillan, 1973), the Repetitive Behaviours Interview (RBI; Turner, 1999), the Repetitive Behaviour Scale (RBS-R; Bodfish, Symons, & Lewis, 1998) and Repetitive Behaviour Scale-Revised (RBS-R: Lam & Aman, 2007) and the Repetitive Behaviour Questionnaire (RBQ; Honey, McConachie, Turner, & Rodgers, 2012; Turner, 1995) and the RBQ-2 (Leekam, Tandos, et al., 2007). A self-report version of the RBQ (RBQ-2A) (Barrett et al., 2015) is a standardised self-report measure for able young people and adults. Direct observation has also been used as part of the widely used semi-structured clinical assessment and research tool, the Autism Diagnostic Observation Schedule (ADOS; Lord et al., 2000) and a small number of studies have used direct observation and time sampling methods within the framework of behavioural analysis to measure and investigate repetitive behaviours. Thus, research efforts have attempted to bring order to the heterogeneity of repetitive behaviours by investigating questions of phenomenological, conceptual, taxonomic, epidemiological and functional similarity at a group level across this diverse range of phenomena.

Developmental Issues

Chronological age is an important factor when considering repetitive behaviour in autism in addition to developmental delay/level. Militerni, Bravavvio, Falco, Fico, and Palermo (2002) found that younger autistic children were more likely to show lower-order repetitive behaviours with older autistic children more likely to show higher-order repetitive behaviours. Lam and Aman (2007) found that while self-injurious behaviour and compulsions were comparable across age groups in autism, stereotyped movements and restricted interests were less frequently observed, and ritualistic or sameness behaviour more frequently observed, in older age groups. In an attempt to further understand the role of intellectual impairment and age, Esbensen, Seltzer, Lam, and Bodfish (2009) combined data from a number of studies using the RBS-R to conduct a large ($n = 712$) cross-sectional analysis of repetitive behaviours. The sample ranged from 2 to 62 years of age and 62.2% had intellectual disability in addition to autism. The authors found that the adults in the study showed fewer of all types of repetitive behaviours as measured by the different sub-scales of the RBS-R repeating the finding that increasing age is associated with decreasing repetitive behaviours. The age-related reduction was most marked for the restricted interests sub-scale. Again the authors established in their data set that intellectual disability was significantly associated with repetitive behaviour, in particular with lower-order repetitive behaviours and this domain showed a less pronounced reduction with age when intellectual disability was present. Bishop, Richler, and Lord (2006) also sought to understand the interaction between age, intellectual ability and restricted repetitive behaviours in a group of 830 children with autism. On this occasion the upper age limit was 12 years and non-verbal abilities were taken as an index of cognitive function. The authors found that non-verbal ability was significantly negatively correlated with lower-order repetitive behaviours such as unusual sensory interests, hand and finger mannerisms, self-injury, repetitive use of objects and other complex mannerisms. However, higher-order repetitive behaviours such as circumscribed interests and compulsions and rituals were more commonly reported in children with higher non-verbal ability. Overall, therefore, these findings are consistent with the proposal that lower-order repetitive behaviours are associated with developmental delay and impaired cognitive ability generally, whereas higher-order repetitive behaviours are autism-specific and persist into the later developmental period.

‘Normal’ and ‘Pathological’ Levels of Repetitive Behaviour

Repetitive behaviours are very much a part of typical development (Piaget, 1950), easily observed during the first year of infancy (Thelen, 1979) and declining after 48 months (Evans et al., 1997). Repetitive behaviours are also common in healthy adults, where stereotypies or seemingly pointless, habitual repetitive movements are evident, particularly where an individual is bored or under stress (Asendorpf, 1980; see also Chap. 9 in this volume). Repetition is an important aspect of almost all levels of behaviour across all species but can become pathological if there is excessive occurrence of a behavioural programme or, when there is a lack of self-initiated, variable and novel behaviour. Pathological repetition can occur at many levels of function ranging from the observable excessive occurrence of simple motor acts (lower order) and difficulties at the conceptual or organizational level, perhaps in planning and strategy formation (higher order). Pathological repetitive behaviours have been observed across a number of clinical conditions including

Schizophrenia (Frith & Done, 1983), and Frontal Lobe Syndrome (Luria, 1973) amongst others. Although higher-order repetitive behaviours are more common in autistic people than typically developing people, it is not clear if they are truly 'pathological' or an understandable, functional part of the autism picture. Research has sought to consider how repetitive behaviours in autism depart from the repetitive behaviours observed in typical development. General population studies (e.g. Evans et al., 1997; Leekam, Tandos, et al., 2007) have found using standard measurement tools that typically developing children between ages 2 and 3 years show a wide range of repetitive behaviours associated with autism. The break with typical development in autism is thus temporal rather than qualitative, at least in young children. The departure from typical development may be better understood as a failure to develop novel behaviours and hence repetitive behaviour continues without cessation. This would seem to be the case for lower-order repetitive behaviours in those with intellectual disability and developmental delay (with or without autism) and for higher-order repetitive behaviours in those with autism.

Thus, repetitive behaviours are part of typical development in the early years. Lower-order repetitive behaviours appear to be associated with general developmental delay once the peak of non-pathological repetition has passed at age 48 months and may represent stimulus-driven rather than 'willed' behaviours. Within autism however, increasing age is associated with decreasing occurrence of lower-order repetitive behaviours, whilst higher-order repetitive behaviours seem to be more likely in autistic people of average intellectual ability (or above).

Functions of Repetitive Behaviour

One avenue of research into repetitive behaviours has been to try and understand why they are being initiated, that is, their function. Recent research of repetitive behaviours in autism has proposed that repetition may serve to reduce chronically high anxiety levels in autism. Whilst anxiety is not a diagnostic characteristic of autism, anxiety occurs at clinically significant levels in around two thirds of autistic people (Simonoff et al., 2008). Rodgers et al. (2017) found a significant association between scores on the Repetitive Behaviour Questionnaire (RBQ), particularly the higher-order sub-scale and total scores on the Spence Children's Anxiety Scale (SCAS) in a group of 67 young people with autism. Lidstone et al. (2014) similarly found that a significant association between RBQ-2 and anxiety scores reflected a significant correlation between the higher-order sub-scale and anxiety, but not the lower-order sub-scale. Neither study measured symptoms of Obsessive Compulsive Disorder (OCD), a potential confound with high rates of obsessive-compulsive symptoms reported in autistic people (McDougle et al., 1995; Russell et al., 2016). The issue of anxiety-based obsessive-compulsive symptoms represents a potential confound of some complexity when investigating repetitive behaviours in autism and has become a field of research in its own right (e.g. Zandt, Prior, & Kyrios, 2007). As well as high rates of anxiety disorders, particularly social anxiety, high rates of OCD have been reported across the lifespan in autism (Zandt et al., 2007). OCD comprises repeated, unwanted, intrusive thoughts associated with distress and compulsions, actions which an individual feels compelled to perform, often in response to obsessions. Heavily reliant on self-report, obsessive-compulsive symptoms in less verbally able children and adults with autism can be difficult to disentangle from some forms of repetitive behaviours. Nonetheless, there is vast empirical evidence demonstrating the role of anxiety in the development and maintenance of OCD and consequently studies considering the function of repetitive behaviours in autism need to be mindful of anxiety-based obsessive-compulsive symptoms.

Interventions for Repetitive Behaviours

Despite the prominence of repetitive behaviours in autistic children (and adults) and the associated management challenges for parents, care-givers and service providers (Bishop et al., 2007; Lecavalier et al., 2006; South et al., 2005), repetitive behaviours are rarely targeted for intervention and no standardized recommendations for treatment exist (see Boyd, McDonough, & Bodfish, 2012; Leekam, Prior, et al., 2011 for reviews). One of the reasons repetitive behaviours can be 'treatment resistant' is a failure to consider WHY the autistic person is engaging in repetitive behaviours, i.e. considering their function (Leekam, Prior, et al., 2011). Militerni et al. (2002) in a study aiming to understand the function of, or environmental factors associated with, repetitive behaviours in a relatively large sample of young autistic children (n = 121) used a combination of parental report and direct clinic observation. The authors found that simple, motor sequences seemed to be relatively purposeless and consistent with behaviours observed in typical development, while sensory-based behaviours presented as highly reactive, either to environmental or internal cues. Also carefully delineating repetitive phenomena according to behavioural topography may not be ideal. In operant accounts, very different behaviours can share the same functional class. Conversely a single behaviour can have many different functions. Of note, the authors could identify no studies where able young people and adults' accounts of why they do what they do have been subject to systematic enquiry.

Thus whilst repetitive behaviour may be perceived to be the most challenging aspect of autism for parents/carers, this may not be the case for autistic individuals themselves. If the function of a higher-order repetitive behaviour is to reduce anxiety, intervening to disrupt the higher-order repetitive behaviour may have adverse impact upon anxiety levels in the autistic individual. Within the literature on challenging behaviour (generally, not repetitive behaviour specifically), again research has highlighted how identifying the function of the behaviour that is perceived to be challenging is crucial for successful intervention. Challenging behaviour is a descriptive term for '*culturally abnormal behaviour of such an intensity, frequency or duration, that the physical safety of the person or others is placed in serious jeopardy or behaviour which is likely to seriously limit the use of, or result in the* *person being denied access to ordinary community facilities*' (Emerson, 2000). Challenging behaviour can be understood within operant learning theory as purposeful behaviour, a means by which a person with compromised resources seeks to exercise some choice and control over their environment. Hence it is a form of behaviour which is shaped and maintained by environmental events. Challenging behaviour functions to access a desired event or avoid an undesired event, with reinforcement processes highlighted by the contingent relationship between behaviour and antecedent factors, and/or consequences. A commonly used assessment tool, the Motivation Assessment Scale (MAS: Durand & Crimmins, 1992) ascribes four main functional categories to a target behaviour, namely: sensory motivated behaviours, demand-escape, access to attention, and access to tangible resources. Functional analysis is a highly individualised process, and behaviours which are topographically similar across individuals may fulfil very different functions, with the converse also holding true. There is no reason to suppose that repetitive behaviours can be ascribed the same function across all autistic people but it is plausible that there may be formulations which are common to numbers of people with autism. For example, insisting on a highly routinized performance of an activity such as taking the same route to school each day may function to avoid the anxiety emerging from uncertain interactions or events on a novel route. Alternatively, it may be that the preferred route provides access to objects of intense interest or pleasure. Alternatively, repetitive behaviours may function to reduce access to unwanted social attention and communication by facilitating disengagement from interpersonal situations, they may be a source of internal stimulation or a means of escape from or coping with a demanding sensory environment.

Theory

Much theoretical work on autism has focussed upon the social communication deficits or an attention to local detail at the cost of global details (e.g. Baron-Cohen, Leslie, & Frith, 1985; Happé & Frith, 2006). The Theory of Mind account of autism, for example, proposes relative impairments in the ability to make inferences about mental states such as the thoughts, beliefs and intentions of others. Theory of Mind abilities are assumed to extend intra- as well as inter-personally. It is assumed that difficulties making inferences about the mental states of others are accompanied by similar difficulties in reasoning about one's own mental state. Whilst not explicitly addressing repetitive behaviours, Theory of Mind may be pertinent as Williams and Happé (2010) attribute impairments in self-Theory of Mind (or 'metacognition') in autism in an inability to distinguish reflex behaviour from intended behaviour. When eliciting the classic knee-jerk reflex by tapping the knee with a hammer, autistic people were more likely to report that they had intended to jerk their leg. There was an apparent deficit in distinguishing one's intention between automatic and non-automatic behaviours (see also Brosnan, Johnson, et al., 2016; Maras, Gamble, & Brosnan, 2017). As noted above, deficits in metacognition can also impact upon researchers' capacity to ask autistic people why they engage in repetitive behaviours.

There are two theoretical accounts of autism that may relate more directly to repetitive behaviours, although evidence is mixed. The first is the Executive Function (EF) theory of autism. EFs refers to the neuropsychological processes critical to goal-directed, future-oriented behaviour, thought to be under the control of the frontal regions of the brain and described by Shallice and Burgess (1991) as the abilities involved in planning and strategy formation, flexibility, inhibition of pre-potent responses and generation of novel responses. Studies have identified impairments in the majority of these functions in autism and a recent meta-analysis concluded an effect of overall impairment in EF in autism, with little evidence for a selective impairment in terms of fractionation of EF (Demetriou et al., 2018). There has been research investigating the relationship between facets of EF and repetitive behaviours. For example, Turner (1999) found a significant association between scores on Use of Objects, Ideational and Design Fluency (generativity tasks) and repetitive behaviours. Conversely, Lopez, Lincoln, Ozonoff, and Lai (2005) found that it was cognitive flexibility which had a unique contribution to repetitive behaviour scores not planning and generativity. Other researchers have found no association between EF deficits and repetitive behaviours (e.g. Boyd, McBee, Holtzclaw, Baranek, & Bodfish, 2009; Dichter, Lam, Turner-Brown, Holtzclaw, & Bodfish, 2009; Zandt, Prior, & Kyrios, 2009). Thus whilst perseveration associated with EF deficits may have an intuitive appeal for an account of the maintenance of higher-order repetitive behaviours in autism, evidence is far from consistent.

The second theory of autism that may be relevant to repetitive behaviours is the Dual Process Theory of Autism (Brosnan & Ashwin, 2018; Brosnan, Ashwin, & Lewton, 2017; Brosnan, Lewton, & Ashwin, 2016). Within Dual Process Theory (Evans & Stanovich, 2013), the dual processes are Type 1 processing, which is preconscious, automatic and rapid, and Type 2 processing, which is conscious, deliberative and slow. Typically, people engage in Type 1 processing unless overridden by Type 2 processing. The Dual Process Theory of Autism proposes that autism is characterised by a dominance of Type 2 processing over Type 1 processing. Through a range of tasks, autistic people consistently demonstrate Type 2 behaviour in situations where Typically Developing people demonstrate Type 1 behaviour. Typically people can be encouraged to engage in Type 2 behaviour and over-ride their prepotent Type 1 response (for example by being told to reflect upon a situation and write down why they are responding in a certain way). It is unknown whether autistic people are over-riding Type 1 processing with dominant Type 2 processing or whether Type 1 processing is impaired (or absent). Under this framework, it is the intuitive 'automatic' aspects of Theory of Mind (see above) in rapid dynamic real world situations that pose difficulties for many autistic people. Many social communication deficits are seen as deficits in automatic processing. There can also be many strengths associated with autism, such as great attention to detail or a preference for logical, systematic thinking which is consistent with a preference for Type 2 processing.

One advantage of Type 2 processing is that it supports the capacity to make effective predictions and minimise prediction error (see Baron-Cohen, Ashwin, Ashwin, Tavassoli, & Chakrabarti, 2009). Making prediction errors correlates with higher levels of anxiety in autistic people (Garfinkel et al., 2016), and engaging in Type 2 processing may relate to a strategic attempt to minimise prediction errors and anxiety. However this is only effective in contexts that allow the time required to engage in Type 2 processing. Social situations are typically very rapid and draw upon automatic Type 1 processing to be effective. There is good evidence that autistic people engage in Type 2 processing in contexts in which typically people engage in Type 1 processing (such as social contexts) which is extremely effortful and often unsuccessful in real world situations (see Harms, Martin, & Wallace, 2010). Speculatively, engaging in repetitive behaviours may be a mechanism by which novelty is minimised and prediction errors are minimised. This theorises a potential relationship between Type 2 processing and repetitive behaviours which may be more pertinent for higher-order cognition and consequently the autism-specific higher-order repetitive behaviours. Within the Dual Process Theory of higher-order cognition (Evans & Stanovich, 2013), there are multiple Type 1 systems of different kinds, including habitual forms of processing. A greater understanding of habits will therefore inform a more detailed understanding of repetitive behaviours in autism, specifically higher-order repetitive behaviours.

Habits

Verplanken's habit research has focussed upon the function of the habit (Verplanken & Orbell, 2003) and may therefore be particularly pertinent for better understanding restricted behaviours in autism. A habit can be defined as behaviour contextually cued, without conscious thought, via activation of a mental context-behaviour association learned through context-consistent performances (see Gardner, 2015). Definitions vary as to whether a habit is defined as a type of behaviour or as a type of automaticity—that is a cognitive mechanism independent of behaviour (Verplanken & Wood, 2006; Wood & Neal, 2009; see also Chap. 2 in this volume). Gardner (2015, p. 280) proposes that such definitional differences can be resolved by viewing habit as 'a process by which a stimulus automatically generates an impulse towards action, based on learned stimulus-response associations'. Also pertinent from Verplanken's (Verplanken, 2006; Verplanken, Friborg, Wang, Trafimow, & Woolf, 2007; see also Chap. 15 in this volume) research is the proposal of 'mental habits' that may be a useful framework for considering the autism-specific higher-order repetitive behaviours. Mental habits are considered in terms of mental process distinguished from mental content. Verplanken et al. (2007) propose that mental habits are unintended, are initiated without awareness, are difficult to control and are distinct from rumination and mindfulness. The authors focussed upon a 'negative self-thinking habit' that predicted anxiety symptoms 9 months later (in addition to other factors). This framework invites the initial question as to the extent to which higher-order repetitive behaviours in autism are unintended, initiated without awareness and difficult to control.

Thus Verplanken et al. argue that although a history of repetition is part of the habit concept, repetition alone is not enough to qualify a behaviour as habit. Repetitive behaviours in autism are present from early childhood, and thus by definition autistic repetitive behaviour has a history of repetition. Verplanken & Orbell (2003) argue that most conceptual definitions of habit contain other elements in addition to behavioural frequency, most notably the qualification of habit as behaviour that has acquired a certain degree of automaticity. Within this view, automaticity may be broken down into four features: (1) lack of awareness; (2) mental efficiency; (3) lack of control; and (4) lack of conscious intent (the 'four horsemen of automaticity'). The presence or absence of each of these features yields a variety of variants of automaticity. So, what pattern of automaticity characterises repetitive behaviour in autism (or how autistic are the four horsemen of automaticity)?

A Lack of Awareness

Autism has been associated with impairments in metacognition, which can manifest as a lack of self-awareness. Difficulties interpreting your own feelings and intentions (see Theory of Mind, above) may relate to a lack of awareness of repetitive behaviours. The extent to which an autistic person is aware they are engaging in repetitive behaviours may be a feature of whether lower-order or higher-order behaviours are being considered as well as the function of the repetitive behaviour. Systematic studies of first-person introspective accounts on this aspect are few and far between and thus the extent to which autistic people are aware of their autism-specific higher-order repetitive behaviour remains an unanswered question.

Being Mentally Efficient

We have observed in this chapter, that autistic people may be reliant on Type 2, effortful processing and this may be particularly true in respect of social stimuli. An effortful processing style may be associated with an enhanced need for mental efficiency at other times, perhaps in the form of cognitive 'down-time'. It seems plausible that repetitive mental and behavioural acts may counter-balance the periods of effortful processing by providing periods of efficient, predictable and more automatic processing. Thus repetitive behaviours in autism may provide us with a window into the optimal balance of effortful versus automatic processing required by humans to manage limited information processing capacity.

Sometimes Difficult to Control

Autistic people can have a focused interest on a particular topic which can be enjoyable and stimulating. However, these interests can also significantly interfere with everyday functioning (Mercier, Mottron, & Belleville, 2000), which may be some indication that this focused interest mentally and behaviourally is not be entirely under an individual's control. Mercier et al. found that autistic adults reported that restricted interests played a significant role in their lives that was acknowledged by most of their relatives. They provided a sense of well-being, a positive way of occupying one's time, a source of personal validation, and an incentive for personal growth. However, these positive dimensions were counterbalanced by their negative consequences, resulting in active processes to adapt, reduce or diversify their restricted interests.

A Lack of Conscious Intent

Lower-order repetitive behaviour is more likely to be stimulus-bound, a rapid response to internal (e.g. anxiety) or external (e.g. environmental opportunity) cues and thus lacking in conscious intent. Whether higher-order autistic repetitive behaviours are associated with a lack of conscious intent presents an interesting question. Behaviours which are engaged in pursuit of a circumscribed interest e.g. seeking out items of interest or mentally listing all the preferred characters in a film will require conscious intent. Whether the preference for a restricted range of interests and activities is consciously intended or part of a neurobiological constitution is less certain. Thus, if autism is characterised by a restricted range of mental habits (repetitive thinking), the restriction may be without conscious intent, whereas the repetition may be with conscious intent.

Considering the four horsemen of automaticity from the habit literature may therefore be informative for understanding repetitive behaviour in autism, specifically how the automaticity of mental habits may relate to higher-order, autism-specific repetitive behaviours. Firstly, a history of repetition is a defining feature of autism. The level of awareness and conscious intent is an interesting area as it seems likely that an autistic person with a circumscribed interest will be aware of this interest or will be aware that they have a preferred route for going home from school (for example). It also seems likely that this would be accompanied by a conscious intent to talk about their circumscribed interest or to adhere to their routine. This may be rewarding in itself as well as anxiety reducing and potentially difficult to control. However, it may be that the autistic person is not motivated to control the repetitive behaviour, whereas family members may be motivated to try and do so. Many of the interventions to address repetitive behaviours address 'challenging repetitive behaviours', which are typically challenging to the family (and may have a function for the autistic individual). Being mentally efficient also raises interesting questions. Dual Process Theory proposes that habitual thinking is an automatic Type 1 process, however the Dual Process Theory of Autism proposes a bias away from automatic Type 1 processing.

Thus habits and repetitive behaviours may share a history of repetition, but may be distinguished from each other in terms of automaticity. The presence or absence of each of the 'four horsemen of automaticity' is argued within the mental habits literature to yield 'a variety of variants of automaticity'. It is an intriguing hypothesis that mental habits might represent automatic Type 1 processing whereas autistic higher-order repetitive behaviours might represent automatic Type 2 processing. It would be fascinating if effortful processing was the default in autism, that is 'automatic' in the sense that it is not initiated after Type 1 processing. Within this framework we could speculate that a drive for repetition minimises cognitive resources (e.g. humans being 'cognitive misers'), which is typically achieved through the automaticity of (Type 1) mental habits. However, higher-order repetative behaviours may emerge in autism as a response to a drive for repetition combined with a bias away from the automaticity of Type 1 processing - a distinction which could be assessed emprically. The mechanisms by which habits develop (shift from Type 2 to Type 1 processing?) may therefore provide an interesting perspective. Might repetitive behaviour arise from this shift not occurring in autism? The findings that mental habits and repetitive behaviours are both related to levels of anxiety may also suggest a common function. This can have important implications for how (or if) intervention may impact upon repetitive behaviour. Can the literature on habit change inform interventions for repetitive behaviour in autism?

Framework for Habit Change

Habit change typically seeks to understand the context, the cue and the reward for the habitual routine. For example, Duhigg (2013), evokes three core components of habits; the routine, the cue and the reward. The framework for changing habits therefore is based upon these three components:

Identify the Routine

This concerns the repetitive behaviour you want to change and is typically easily identifiable, such as an insistence on sameness or routine that is problematic (noting this may be problematic for the family rather than the autistic person).

Experiment with Rewards

Our earlier discussions considering the possible functions of repetitive behaviour in autism showcase the potential for repetitive behaviours as coping strategies for a range of hypothesised stressors, such as managing chronically high anxiety levels, as a source of stimulation and pleasure when social interaction is experienced as aversive. In this context, repetitive behaviour may provide activity and structure which require less effort and thereby minimise cognitive load (and are predictable). Repetitive behaviours are at the very core of autism, and an intricate relationship between repetitive behaviour and social communication impairments is likely to exist. There is a diagnosis of Social (Pragmatic) Communication Disorder for children who have social communication and interaction difficulties without repetitive behaviours. There are instances when repetitive behaviours can meet the definition of challenging behaviour and change is desirable for an individual's well-being and quality of life (for example repetitive damaging self-injurious behaviour, or engagement in a circumscribed interest to the exclusion of essential activities of daily living). At a more general level however, introducing change to the 'habit of repetitive behaviour' may not be an ethical or desired outcome. The 'reward' for repetitive behaviour in autism may well be more effective coping with the world. Alternative coping strategies will be required and may not be as easy to institute or as effective.

Isolate the Cue

Once again, if anxiety were the cue, biofeedback systems could serve as a mechanism to isolate the cues for repetitive behaviours. Once isolated, the cue ideally is removed from the environment. Anxiety is a sense of apprehension and is closely related to fear. It has physiological, emotional and cognitive facets and typically occurs in response to specific triggers. In the context of autism, these are often factors such as uncertainty about change, unpredictability, social interaction etc. Removing the cue by making the world a more predictable and less social place to live is inherently impractical.

If we continue with our route home example, let's suppose road works mean you have to alter your route home as you drive your child back from school. If the child starts to rock to and fro, the cue may be the internal detection of raising anxiety levels and the reward may be the alleviation of the feeling of anxiety. The context of such an explanation is crucial. The raised anxiety might be induced by an unexpected change in the environment and this lack of predictability of such change culminated in a repetitive behaviour which is predictable and thereby reduces feelings of anxiety. In this hypothetical example, the cue to the repetitive behaviour could be the detection of unexpected change or the sense of increasing anxiety. The reward could be the re-establishment of the prediction (i.e. the usual route home, not possible in this example) or a reduction in anxiety. Preventing the child engaging in the repetitive behaviour may therefore be denying them access to their only form of anxiety management. Thus the context of the repetitive behaviour—predictability or anxiety—may be crucial to understand in terms of cues and rewards. Indeed, most likely both of these aspects come into the equation. It is also possible that there are circumstances where separating the context, the cue and the reward is not possible. In cases where the behaviour is rewarding in and of itself. Sensory-motor repetitions can fit this bill, and will occur across contexts, independent of cues and automatically reinforcing.

We are left with some important questions following our attempt to map repetitive behaviours in the geography of the habit landscape. These include:

Can the different dimensions of automaticity be operationalised and reliably measured to investigate the relevance for repetitive behaviours in autism (Type 1 vs. Type 2 processing from Dual Process Theory).

How viable is a distinction between higher-order vs. lower-order repetitive behaviours, mental vs. behavioural habits. Is there a different way to conceptualise the heterogeneity of repetitive phenomena e.g. in terms of functional class or automaticity.

What is the function of higher-order repetitive behaviours or mental habits? To what extent are they anxiety management strategies?

How does the restriction in the range of behaviours, interests and activities in autism relate to repetition?

Finally, as we note above much of the motivation for repetitive behaviour research within autism has been to perceived negative (challenging) consequences. A focus upon the positive consequences may enable a better understanding of 'adaptive repetitive behaviours' rather than 'pathological habits'.

Habit Research in Action

Behavioural repetition is relatively easy to observe, and studies have relied on informant reports. Less accessible to measurement is mental repetition. Typically, investigation of habitual thinking is a matter of retrospective and reflective self-report. The validity of this method in autism is under question due to impairments in metacognition (Brosnan, Johnson, et al., 2016; Maras et al., 2017; Williams & Happé, 2010), introspective abilities and recognition of one's own emotional state. Descriptive experience sampling methodology (DESM) is a means of 'catching' internal phenomena in the moment before it is mapped or subject to heuristic processing. DESM was pioneered by Hurlburt, (1993, 1997; Hurlburt & Heavey, 2006) and was successfully used in a small study of adults with autism (Hurlburt, Happé, & Frith, 1994), which found that autistic people's thinking might be represented visually rather than verbally. We have adapted the DES method to address questions about mental repetition, specifically restricted and repetitive thinking in autism, using a structured booklet with prompt questions, space for pictures and use of a smartphone application to aid data collection (Cooper, Russell, Calley, & Verplanken, in preparation). Inductive content analysis of the mental repetition reported by able adults with autism and compared to typically developing adults will answer two simple questions: Do adults with autism have restricted categories or types of thoughts compared to non-autistic adults, and are these categories or types of thought repeated more frequently? Participant ratings of the positive or negative experience of repetitive thoughts will afford some limited insight into the nature of restricted and repetitive mental experience of autism.

References

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Washington, DC.

Asendorpf, J. (1980). Nonreactive stress measurement: Movement stereotypies as arousal indicators. *Zeitschrift fur Experimentelle und Angewandte Psychologie, 27*(1), 44–58.

Baron-Cohen, S., Ashwin, E., Ashwin, C., Tavassoli, T., & Chakrabarti, B. (2009). Talent in autism: Hyper-systemizing, hyper-attention to detail and sensory hypersensitivity. *Philosophical Transactions of the Royal Society B: Biological Sciences, 364*(1522), 1377–1383.

Baron-Cohen, S., Leslie, A. M., & Frith, U. (1985). Does the autistic child have a "theory of mind"? *Cognition, 21*(1), 37–46.

Barrett, S. L., Uljarević, M., Baker, E. K., Richdale, A. L., Jones, C. R. G., & Leekam, S. R. (2015). The adult repetitive behaviours questionnaire-2 (RBQ-2A): A self-report measure of restricted and repetitive behaviours. *Journal of Autism and Developmental Disorders, 45*(11), 3680–3692. https://doi.org/10.1007/s10803-015-2514-6

Bishop, S. L., Richler, J., & Lord, C. (2006). Association between restricted and repetitive behaviours and nonverbal IQ in children with autism spectrum disorders. *Child Neuropsychology, 12*, 247–267.

Bishop, S. L., Richler, J., Cain, A. C., & Lord, C. (2007). Predictors of perceived negative impact in mothers of children with autism spectrum disorder. *American Journal on Mental Retardation, 112*(6), 450–461.

Bodfish, J. W., Symons, F. J., & Lewis, M. H. (1998). *The repetitive behaviour scale: A test manual*. Western Carolina: Center Research Reports.

Boyd, B. A., McBee, M., Holtzclaw, T., Baranek, G. T., & Bodfish, J. W. (2009). Relationships among repetitive behaviors, sensory features, and executive functions in high functioning autism. *Research in Autism Spectrum Disorders, 3*(4), 959–966.

Boyd, B. A., McDonough, S. G., & Bodfish, J. W. (2012). Evidence-based behavioral interventions for repetitive behaviors in autism. *Journal of Autism and Developmental Disorders, 42*(6), 1236–1248.

Brosnan, M., & Ashwin, C. (2018). *Reasoning on the autism spectrum. Encyclopedia of autism spectrum disorders* (pp. 1–7). Springer.

Brosnan, M., Ashwin, C., & Lewton, M. (2017). Brief report: Intuitive and reflective reasoning in autism spectrum disorder. *Journal of Autism and Developmental Disorders, 47*(8), 2595–2601.

Brosnan, M., Johnson, H., Grawemeyer, B., Chapman, E., Antoniadou, K., & Hollinworth, M. (2016). Deficits in metacognitive monitoring in mathematics assessments in learners with autism spectrum disorder. *Autism, 20*(4), 463–472.

Brosnan, M., Lewton, M., & Ashwin, C. (2016). Reasoning on the autism spectrum: A dual process theory account. *Journal of Autism and Developmental Disorders, 46*(6), 2115–2125.

Cuccaro, M. L., Shao, Y., Grubber, J., Slifer, M., Wolpert, C. M., Donnelly, S. L., et al. (2003). Factor analysis of restricted and repetitive behaviors in autism using the Autism Diagnostic Interview-R. *Child Psychiatry and Human Development, 34*(1), 3–17.

Demetriou, E. A., Lampit, A., Quintana, D. S., Naismith, S. L., Song, Y. J. C., Pye, J. E., et al. (2018). Autism spectrum disorders: A meta-analysis of executive function. *Molecular Psychiatry, 23*(5), 1198–1204.

Dichter, G. S., Lam, K. S. L., Turner-Brown, L. M., Holtzclaw, T. N., & Bodfish, J. W. (2009). Generativity abilities predict communication deficits but not repetitive behaviors in autism spectrum disorders. *Journal of Autism and Developmental Disorders, 39*, 1298–1304.

Duhigg, C. (2013). *The power of habit: Why we do what we do and how to change*. Random House.

Durand, V. M., & Crimmins, D. B. (1992). *The Motivation Assessment Scale (MAS) administration guide*. Topeka, KS: Monaco and Associates.

Emerson, E. (2000). *Challenging behavior: Analysis and intervention in people with intellectual disabilities* (2nd ed.). Cambridge: Cambridge University Press.

Esbensen, A. J., Seltzer, M. M., Lam, K. S. L., & Bodfish, J. W. (2009). Age-related differences in restricted repetitive behaviours in autism spectrum disorders. *Journal of Autism and Developmental Disorders, 39*, 57–66.

Evans, D. W., Leckman, J. F., Carter, A., Reznick, J. S., Henshaw, D., King, R. A., et al. (1997). Ritual, habit and perfectionism: The prevalence and development of compulsive-like behaviour in normal young children. *Child Development, 68*(1), 58–68.

Evans, J. S. B., & Stanovich, K. E. (2013). Dual-process theories of higher cognition: Advancing the debate. *Perspectives on Psychological Science, 8*(3), 223–241.

Frith, C. D., & Done, D. J. (1983). Stereotyped responding by schizophrenic patients on a two-choice guessing task. *Psychological Medicine, 13*, 779–786.

Gardner, B. (2015). A review and analysis of the use of 'habit' in understanding, predicting and influencing health-related behaviour. *Health Psychology Review, 9*(3), 277–295.

Garfinkel, S. N., Tiley, C., O'Keeffe, S., Harrison, N. A., Seth, A. K., & Critchley, H. D. (2016). Discrepancies between dimensions of interoception in autism: Implications for emotion and anxiety. *Biological Psychology, 114*, 117–126.

Happé, F., & Frith, U. (2006). The weak coherence account: Detail-focused cognitive style in autism spectrum disorders. *Journal of Autism and Developmental Disorders, 36*(1), 5–25.

Happé, F., Ronald, A., & Plomin, R. (2006). Time to give up on a single explanation for autism. *Nature Neuroscience, 9*(10), 1218.

Harms, M. B., Martin, A., & Wallace, G. L. (2010). Facial emotion recognition in autism spectrum disorders: A review of behavioral and neuroimaging studies. *Neuropsychology Review, 20*(3), 290–322.

Harrop, C., McConachie, H., Emsley, R., Leadbitter, K., Green, J., & Consortium, P. A. C. T. (2014). Restricted and repetitive behaviors in autism spectrum disorders and typical development: Cross-sectional and longitudinal comparisons. *Journal of Autism and Developmental Disorders, 44*(5), 1207–1219.

Honey, E., McConachie, H., Turner, M., & Rodgers, J. (2012). Validation of the repetitive behaviour questionnaire for use with children with autism spectrum disorder. *Research in Autism Spectrum Disorders, 6*(1), 355–364.

Hurlburt, R. T. (1997). Randomly sampling thinking in the natural environment. *Journal of Consulting and Clinical Psychology, 65*(6), 941.

Hurlburt, R. T. (1993). *Sampling inner experience in disturbed affect*. New York: Plenum Press.

Hurlburt, R. T., & Heavey, C. L. (2006). *Exploring inner experience*. Amsterdam: John Benjamins.

Hurlburt, R. T., Happé, F., & Frith, U. (1994). Sampling the form of inner experience in three adults with Asperger syndrome. *Psychological Medicine, 24*, 385–339.

Kanner, L. (1973). *Childhood psychosis: Initial studies and new insights*. Washington D.C.: Winston/Wiley.

Kasari, C., & Lawton, K. (2010). New directions in behavioral treatment of autism spectrum disorders. *Current Opinion in Neurology, 23*, 137–143.

Lam, K. S. L., & Aman, M. G. (2007). The Repetitive Behaviour Scale-Revised: Independent validation in individuals with autism spectrum disorders. *Journal of Autism and Developmental Disorders, 37*, 885–866.

Lecavalier, L., Leone, S., & Wiltz, J. (2006). The impact of behaviour problems on caregiver stress in young people with autism spectrum disorders. *Journal of Intellectual Disability Research, 50*, 172–183.

Leekam, S. R., Prior, M. R., & Ulkarevic, M. (2011). Restricted and repetitive behaviors in autism spectrum disorders: a review of research in the last decade. *Psychological Bulletin, 137*(4), 562–593.

Leekam, S., Tandos, J., McConachie, H., Meins, E., Parkinson, K., Wright, C., et al. (2007). Repetitive behaviours in typically developing 2 year olds. *Journal of Child Psychology and Psychiatry, 48*(11), 1131–1138.

Lidstone, J., Uljarevic, M., Sullivan, J., Rodgers, J., McConachie, H., Freeston, M., et al. (2014). Relations among restricted and repetitive behaviours, anxiety and sensory features in children with autism spectrum disorders. *Research in Autism Spectrum Disorders, 8*(2), 82–92.

Lopez, B. R., Lincoln, A. J., Ozonoff, S., & Lai, Z. (2005). Examining the relationship between executive functions and restricted, repetitive symptoms of autistic disorder. *Journal of Autism and Developmental Disorders, 35*(4), 445–460.

Lord, C., Rutter, M., & Le Couteur, A. (1994). Autism diagnostic interview-revised: A revised version of a diagnostic interview for caregivers of individuals with possible pervasive developmental disorders. *Journal of Autism and Developmental Disorders, 24*(5), 659–685.

Lord, C., Risi, S., Lambrecht, L., Cook, E. H., Leventhal, B. L., Pickles, A., et al. (2000). The autism diagnostic observation schedule-generic: A standard measure of social and communication deficits associated with the spectrum of autism. *Journal of Autism and Developmental Disorders, 30*(3), 205–223.

Luria, A. R. (1973). *The working brain*. New York: Basic Books.

Maras, K., Gamble, T., & Brosnan, M. (2017). Supporting metacognitive monitoring in mathematics learning for young people with autism spectrum disorder: A classroom-based study. *Autism*, 1362361317722028.

McDougle, C. J., Kresch, L. E., Goodman, W. K., Taylor, S. T., Volkmar, F. R., Cohen, D. J., et al. (1995). A case-controlled study of repetitive thoughts and behavior in adults with autistic disorder and obsessive-compulsive disorder. *American Journal of Psychiatry, 152*(5), 772–777.

Mercier, C., Mottron, L., & Belleville, S. (2000). A psychosocial study on restricted interests in high functioning persons with pervasive developmental disorders. *Autism, 4*(4), 406–425.

Militerni, R., Bravavvio, C., Falco, C., Fico, C., & Palermo, M. T. (2002). Repetitive behaviours in autistic disorder. *European Child & Adolescent Psychiatry, 11*, 210–218.

Mooney, E. L., Gray, K. M., & Tonge, B. J. (2006). Early features of autism. *European Child & Adolescent Psychiatry, 15*(1), 12–18.

Moss, J., Oliver, C., Arron, K., Burbidge, C., & Berg, K. (2009). The prevalence and phenomenology of repetitive behavior in genetic syndromes. *Journal of Autism and Developmental Disorders, 39*(4), 572–588.

Piaget, J. (1950). *The psychology of intelligence*. London: Routledge & Kegan Paul.

Prior, M., & MacMillan, M. B. (1973). Maintenance of sameness in children with Kanner's syndrome. *Journal of Autism and Childhood Schizophrenia, 3*, 154–167.

Richler, J., Bishop, S. L., Kleinke, J. R., & Lord, C. (2007). Restricted and repetitive behaviors in young children with autism spectrum disorders. *Journal of Autism and Developmental Disorders, 37*(1), 73–85.

Rodgers, J., Hodgson, A., Shields, K., Wright, C., Honey, E., & Freeston, M. (2017). Towards a treatment for intolerance of uncertainty in young people with autism spectrum disorder: Development of the coping with uncertainty in everyday situations (CUES©) programme. *Journal of Autism and Developmental Disorders, 47*(12), 3959–3966.

Ronald, A., Happé, F., Bolton, P., Butcher, L. M., Price, T. S., Wheelwright, S., et al. (2006). Genetic heterogeneity between the three components of the autism spectrum: A twin study. *Journal of the American Academy of Child & Adolescent Psychiatry, 45*(6), 691–699.

Russell, A. J., Murphy, C. M., Wilson, E., Gillan, N., Brown, C., Robertson, D. M., et al. (2016). Short Report: The mental health of individuals referred for assessment of autism spectrum disorder in adulthood: A clinic report. *Autism, 20*(5), 623–627.

Shallice, T., & Burgess, P. W. (1991). Deficits in strategy application following frontal lobe damage in man. *Brain, 114*, 727–741.

Simonoff, E., Pickles, A., Charman, T., Chandler, S., Loucas, T., & Baird, G. (2008). Psychiatric disorders in children with autism spectrum disorders: Prevalence, comorbidity, and associated factors in a population-derived sample. *Journal of the American Academy of Child and Adolescent Psychiatry, 47*(8), 921–929.

South, M., Ozonoff, S., & McMahon, W. M. (2005). Repetitive behavior profiles in Asperger syndrome and high-functioning autism. *Journal of Autism and Developmental Disorders, 35*, 145–158.

Thelen, E. (1979). Rhythmical stereotypies in normal human infants. *Animal Behaviour, 27*, 699–715.

Turner, M. (1995). *Repetitive behaviour and cognitive functioning in autism*. Unpublished PhD thesis, University of Cambridge.

Turner, M. (1999). Annotation: Repetitive behaviour in autism: A review of psychological research. *Journal of Child Psychology and Psychiatry and Allied Disciplines, 40*(6), 839–849.

Verplanken, B. (2006). Beyond frequency: Habit as mental construct. *British Journal of Social Psychology, 45*(3), 639–656.

Verplanken, B., Friborg, O., Wang, C. E., Trafimow, D., & Woolf, K. (2007). Mental habits: Metacognitive reflection on negative self-thinking. *Journal of Personality and Social Psychology, 92*, 526–541.

Verplanken, B., & Orbell, S. (2003). Reflections on past behavior: A self-report index of habit strength. *Journal of Applied Social Psychology, 33*(6), 1313–1330.

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

Williams, D. M., & Happé, F. (2010). Representing intentions in self and other: Studies of autism and typical development. *Developmental Science, 13*, 307–319.

Wood, W., & Neal, D. T. (2009). The habitual consumer. *Journal of Consumer Psychology, 19*, 579–592.

Zandt, F., Prior, M., & Kyrios, M. (2007). Repetitive behaviour in children with high functioning autism and obsessive compulsive disorder. *Journal of Autism and Developmental Disorder, 37*(2), 251–259.

Zandt, F., Prior, M., & Kyrios, M. (2009). Similarities and differences between children and adolescents with autism spectrum disorder and those with obsessive compulsive disorder: Executive functioning and repetitive behaviour. *Autism, 13*, 43–57.

Chapter 20
Mind Wandering: More than a Bad Habit

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Much of our behaviour is determined by habits, as we can readily observe in our daily repeating routines and struggles with the way we eat, sleep, and manage our time. Aside from habitual behaviour, we are also guided by *mental habits*, habitual patterns in the way we think and feel. When making a mistake, for instance, we may instantaneously jump to negative judgements about ourselves (Verplanken, Friborg, Wang, Trafimow, & Woolf, 2007), or engage in strategies to repair our mood and positive self-image, potentially without even noticing that these mental processes are taking place (Gyurak, Gross, & Etkin, 2011). Such mental habits may be less readily observable, but not necessarily less impactful then habitual behaviour. An important part of our experience that seems to fit the concept of a mental habit is the tenacious tendency for our minds to "wander" away from what we are doing and get drawn towards thoughts unrelated to the here and now. Mind wandering—engaging in stimulus- or task-unrelated thought—occupies roughly half of our waking hours (e.g. Killingsworth & Gilbert, 2010; McVay, Kane, & Kwapil, 2009). Thus, it fits our intuitive idea of habits as something we do frequently. But does mind wandering resemble conventional scientific definitions of habits? Besides something we do frequently, habits are thought of as stimulus–response relationships that unfold in an automatic fashion (Neal, Wood, & Quinn, 2006; Verplanken, 2006; Verplanken & Orbell, 2003). In this chapter, we will examine in what respects mind wandering does and does not fit this definition. Finally, we will discuss how habitual mind wandering, or habitual patterns in our thinking, could be changed.

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Capturing the Wandering Mind: Tools and Types

The broad range of mental events encompassed by the term mind wandering makes it a fuzzy construct. Most generally, mind wandering has been defined as the state that occurs when attention drifts away from the current context and engages in an internal stream of thoughts, ideas, and imagery. This state has historically been referred to by a great number of names, including task-unrelated thought, stimulus-unrelated thought, daydreaming, offline thought, thought intrusions, and spontaneous mental activity (McMillan, Kaufman, & Singer, 2013). Though these terms all share overlapping characteristics, there are nuanced but meaningful differences. Thus, it has been proposed that mind wandering is best conceptualized using a family-resemblances approach, which acknowledges mind wandering as a heterogeneous construct encompassing different definitions with overlapping characteristics (Seli et al., 2018). We will follow this approach here.

Capturing the ceaselessly pulsing contents of the human mind can be a challenging task. The short but rapidly growing history of research in the topic has led to the development of a number of paradigms that differ not only methodologically but also in how mind wandering is conceptualized. Trait measures, which are typically self-report scales, focus on individual differences in how much people *generally* mind wander (e.g. Mrazek, Franklin, Phillips, Baird, & Schooler, 2013) or what they tend to mind wander about most of the time (e.g. Singer & Antrobus, 1970). State measures instead focus on temporary fluctuations in a person's thoughts and attention. An important method for catching such fluctuations is the thought probe method, also called Experience Sampling Methodology (ESM, see Klinger & Cox, 1987 for early work using this approach). This method is typically administered via a computer, smartphone or similar device, and involves periodically interrupting individuals during laboratory tasks or everyday-life activities and asking them whether their thoughts were on task-related or task-unrelated matters. Follow-up questions about what the person was doing, thinking, and feeling when being probed can reveal further information about the qualities of their mind wandering and shed light on repetitive thought patterns (e.g. Kane et al., 2007).

A variation on the thought probe method is the self-caught method, in which individuals report when they themselves notice that their mind has drifted off task (e.g. Schooler, Reichle, & Halpern, 2004; Smallwood & Schooler, 2006). When combined with thought-probes, this approach can distinguish episodes where individuals are aware of the fact that they were mind wandering from episodes where they lacked this awareness before being probed.

Research using these and other measures has revealed important distinctions in the types of mind wandering people experience. One distinguishing factor is intentionality. Oftentimes, people's thoughts unintentionally drift away from the here and now. Other times, people intentionally engage in mental reveries in order to divert their attention from a tedious activity (Giambra, 1995; Seli, Carriere, & Smilek, 2015; Seli, Risko, Smilek, & Schacter, 2016). As we will see, the differentiation between unintentional and intentional mind wandering has implications for the habitual nature of mind wandering. Another important distinction is that between mind wandering that occurs with or without *meta-awareness*, that is, with or without explicit awareness of the fact that one is mind wandering (i.e. mind wandering episodes people "catch" and those they don't). Results from studies combining probe caught with self-caught measures have shown that participants are meta-aware of their mind wandering only a small portion of the time (Schooler et al., 2004). This distinction also has implications for the habitual character of mind wandering.

Is Mind Wandering a Mental Habit?

When asked to record their daily struggles with bad habits over a period of days, research participants reported struggling with mind wandering and engaging in unwanted thoughts at least from time to time (more often, in fact, than they reported stereotypical habitual behaviours such as smoking and drinking or nail biting, but less often than unhealthy eating, poor sleep, procrastination, and unwanted emotions; Quinn, Pascoe, Wood, & Neal, 2010). This suggests that people think about mind wandering in terms of a habit, a "bad habit" even, at least in some contexts. But does mind wandering fit conventional scientific definitions of habits?

Does Mind Wandering Resemble a Stimulus–Response Relationship?

In the psychological literature, habits are commonly understood as stimulus–response relationships, where the encounter of a particular stimulus triggers an associated response. When it comes to mind wandering, the stimulus part of the relationship is puzzling, since it is by definition unrelated to the here and now. However, it turns out that mind wandering can be triggered by cues—particularly cues that remind us of our current concerns and unresolved goals.

An early study by Antrobus, Singer, & Greenberg in 1966 first explored this idea. The researchers invited college students to come to the lab to perform a vigilance task. While participants waited in a waiting room, the radio was playing in the background. For half the participants, the radio program was interrupted by a fabricated breaking news story. The story reported that an attack by communist China had just escalated the Vietnam War, and announced that the military draft was to be extended to all eligible college graduates. This news obviously would have been highly concerning for the participating students at the time. Participants in the control condition heard a neutral radio broadcast without the fabricated news report. Next, all participants were asked to perform a 50-min long vigilance task. Participants in the experimental condition reported roughly 20% more task-unrelated thoughts compared to the control condition. Thus, the results suggest that mind wandering can be understood as a habitual response to cues that evoke personal concerns.

More recently, researchers have used more inconspicuous methods to find further support for this. For instance, McVay and Kane (2013; see also van Vugt, & Broers, 2016) asked participants to write down their current concerns and later embedded participants' own concern-related words directly into a vigilance task. Using the thought probe method, they found that participants were more likely to report that they were mind wandering during the task when they were probed shortly after seeing concern-related words compared to neutral control words. In another study, Kopp, D'Mello, and Mills (2015) evoked current concerns and goals by asking participants to make a list of all the things they needed to do in the next couple of days (goal condition), or to list the components of a car (control condition). Next, participants did a reading task and reported whenever they noticed a task-unrelated thought enter their mind. Participants who had made the to-do-list reported more mind wandering compared to the control group. These results lend further support to the idea that cues related to personal goals and concerns can trigger mind-wandering in a habitual stimulus–response-like fashion.

Masicampo and Baumeister (2011) provided further evidence that it is specifically *unresolved* goals and concerns that trigger habitual mind wandering. They asked participants to write about personal goals in various states of completion. In one condition (control condition), participants described tasks they had recently completed. In another (unresolved goal condition), they described unfinished tasks that needed to be completed in the next few days. In a third condition (plan condition), participants likewise described unresolved future tasks, but then made a detailed plan for when and how to complete them. Next, all participants were asked to read a short story interspersed with thought probes. Probe-caught mind wandering rates in the unresolved task condition were significantly higher than the plan condition. Moreover, participants in the unresolved task condition later reported more mind wandering compared to the other two conditions. Remarkably, making a plan freed participants from this kind of habitual mind wandering. This not only further supports the notion of mind wandering as a habitual response specifically to *unresolved* goals and concerns and not to already completed goals but also points to a strategy to prevent such habitual mind wandering. By consciously thinking about one's goals and concerns and making plans, the tendency for habitual mind wandering can be reduced, potentially freeing us up for more flexible and less habitual thought.

Mind Wandering and Automaticity

Defining a habit merely as a response to a particular cue overlooks something essential about *how* the behaviour is enacted. This essential characteristic is automaticity (Verplanken, 2006; Verplanken & Orbell, 2003). Upon encountering certain cues or situations, habitual behaviour is enacted more or less "automatically", meaning, with some or all of the four features of automaticity: lack of awareness, mental efficiency, lack of control, and lack of conscious intent (Bargh, 1994). Researchers have come to understand that defining habits in this way offers valuable additional explanatory power over and above frequency, both for predicting future behaviour and for understanding why habits are useful, but also so hard to break (e.g. Bayer & Campbell, 2012; Schmidt & Retelsdorf, 2016). Can mind wandering be considered a mental habit according to this definition? And are there more or less automatic forms of mind wandering?

Mental Efficiency

The mental efficiency criterion of automaticity speaks to the amount of mental resources (of a very limited kind) needed to perform a behaviour or mental process. With regard to mind wandering, mental efficiency has been the subject of an unresolved debate, at the center of which are two competing hypotheses about whether mind wandering results from a *lack* of executive control (i.e. the *control-failure hypothesis*; McVay & Kane, 2010) or requires executive control (i.e. the *global availability hypothesis*; Smallwood, 2010; Smallwood & Schooler, 2006; Teasdale et al., 1995).

The control-failure hypothesis (McVay & Kane, 2010) is based on the idea that mind wandering represents the "default" state of the mind, resulting from activity in a network of brain regions termed the "default mode network" due to its ceaseless activity during states of sensory deprivation, rest, or passive and undemanding tasks (e.g. Mason et al., 2007; Raichle et al., 2001). According to the control-failure hypothesis, the default network's basic function is to continuously evaluate a person's life goals and any arising discrepancies with these goals. The network is thought to generate stimulus- and task-unrelated (but goal-relevant) thoughts continuously, unintentionally, and in an effortless or "resource-free" (McVay & Kane, 2010, p. 5) manner. (Note that these thoughts need not be conscious, though.) It is only when an external stimulus or task demands our attention that default network activity and hence mind wandering is actively suppressed. Because suppression requires executive control, task-unrelated thoughts automatically come to the forefront of conscious awareness whenever executive control fails or is relaxed, for instance under conditions of low task demands. Thus, according to this account, mind wandering is automatic, and in that sense habitual, even though it is not the kind of habit that has to be learned and become automatized over time.

According to the global access hypothesis, mind wandering requires cognitive resources by virtue of being consciously experienced. This position is built on the global workspace theory of consciousness (Baars, 2005, 2010; Dehaene & Naccache, 2001). The theory posits that, whereas many unconscious cognitive processes can go on in parallel, supported by highly localized brain activity, access to the "global workspace" of consciousness is limited because it requires integrated activity over many cortical areas. This necessarily limits how much information we can be conscious of at a time. Thus, for task-unrelated thoughts to have access to the global workspace of consciousness means that they must compete for the same scarce resource as other—task-relevant—thought processes. According to this account, mind wandering is then not a habit by way of being mentally efficient.

Although the two hypotheses appear conflicting, they may account for different aspects of mind wandering. The control-failure hypothesis speaks more to the onset of a mind-wandering episode, that is, the switch from stimulus- or task-related thought to mind wandering. It is plausible that cue-elicited switching from task-related thoughts to mind wandering results from a failure to control and explicitly monitor one's current thoughts. This switch could happen quite directly (e.g. Bhangal, Allen, Geisler, & Morsella, 2016; McVay & Kane, 2010; Merrick, Farnia, Jantz, Gazzaley, & Morsella, 2015) and without requiring mental resources. In that sense, it resembles many other habitual responses. The global access hypothesis speaks less to the switch from on- to off-task thought and more to the process of engaging in a train of thought. It is plausible that this indeed relies on limited mental resources, similar to task-related thought. Thus, according to the efficiency criterion of automaticity, the onset of mind wandering may have a habitual character, while pursuing a train of thought is not necessarily habitual.

Lack of Awareness

While it is common to distinguish between conscious (i.e. subjectively experienced) and unconscious processes, another distinction can be made between thoughts and processes that are conscious and those that are accompanied by meta-awareness, explicit awareness of the contents of one's consciousness (e.g. Schooler, 2002). The way mind wandering is conceptualized in the literature is by necessity as a subjective experience. Thus, mind wandering cannot completely lack consciousness, but it can lack meta-awareness. In those cases, a person isn't explicitly aware of the fact that they are mind wandering, and won't "catch" their task-unrelated thoughts, but they can later recall their thoughts when being probed (Schooler, 2002; Schooler et al., 2004, 2011; Smallwood, McSpadden, & Schooler, 2007, 2008; Zedelius, Broadway, & Schooler, 2015).

In the habit literature, this distinction between conscious and meta-aware usually isn't made, and it is unclear whether a behaviour could be considered automatic when it is conscious but lacks meta-awareness. In so far as meta-awareness may be necessary for interrupting a habitual response or initiate flexible, controlled, non-habitual behaviour, there is an argument to be made for defining automaticity more strictly by a lack of meta-awareness. Then, mind wandering could be considered habitual when it lacks meta-awareness, and less habitual when it occurs with meta-awareness.

As pointed out in discussing the efficiency question, it is also relevant here to distinguish between the onset of a mind wandering episode and the process of engaging in a train of thought. It is likely that the origin of a mind-wandering episode, that switch from on-task to off-task, usually occurs entirely unconsciously. Thus, according to the awareness criterion of automaticity, the onset of mind wandering can then be considered a habitual response, while pursuing a train of thought could be more or less habitual, depending on the level of meta-awareness.

If meta-awareness is a determining factor between the distinction between habitual and non-habitual mind wandering, this has implications for ways of to reduce habitual mind wandering. Interestingly, interventions aiming at reducing mind wandering or breaking specific repetitive and habitual patterns of thoughts often center around increasing people's ability to monitor and become meta-aware of their thoughts soon after they inevitably occur (Fox, Kang, Lifshitz, & Christoff, 2016; Morrison, Goolsarran, Rogers, & Jha, 2014; Mrazek, Phillips, Franklin, Broadway, & Schooler, 2013; Tang & Posner, 2009). This is in line with the idea that the onset of mind wandering tends to be a habitual response to some internal or external cue, but that engaging in task-unrelated thought can have a more or less habitual character, depending on our ability to notice and control it or engage in deliberate daydreaming. Interestingly, there is evidence that mind wandering with meta-awareness is less disruptive to performance than mind wandering without meta-awareness (e.g. Franklin, Broadway, Mrazek, Smallwood, & Schooler, 2013; Schooler, Smallwood, Chrisfoff, Handy, Reichle, & Sayette, 2011). In that sense, detrimental mind wandering can indeed be seen as a "bad habit", but clearly mind wandering can be more than that.

Lack of Conscious Intent

We certainly sometimes mind wander intentionally (e.g. Seli et al., 2015), for instance to cope with boredom or because letting the mind wander where it wants or getting absorbed in an engaging daydream can be pleasant or interesting (Franklin, Mrazek, et al., 2013). More often than not, however, mind wandering occurs unintentionally, despite our best efforts to focus on some other task or activity, and despite its negative consequences for performance and mood (e.g. Killingsworth & Gilbert, 2010; Mooneyham & Schooler, 2013). Thus, according to the intentionality criterion, a large proportion of mind wandering seems to be automatic and habitual. The distinction between intentional and unintentional mind wandering has long been acknowledged (e.g. Giambra, 1978, 1995), but only recently have researchers started to empirically examine the differences between the two. These studies have shown that intentional and unintentional mind wandering are predicted by and themselves predict different factors (e.g. Phillips, Mills, D'Mello, & Risko, 2016; Seli, Risko, Smilek, & Schacter, 2016). For instance, intentional mind wandering is greater during easy compared to difficult tasks—in other words, it happens more often during "opportune" moments, when we have the freedom to drift off into a daydream without substantial costs. In contrast, unintentional mind wandering is greater during difficult than easy tasks (Seli, Risko, & Smilek, 2016). This suggests that intentional mind wandering is more controlled and likely less detrimental to performance. It also suggest that unintentional mind wandering has a more habitual character, although more research is needed to explore whether unintentional mind wandering is more strongly stimulus-driven, that is, more often elicited by cues related to unfulfilled goals and revolving around current concerns and less "freely" moving and unconstrained (see Mills, Raffaelli, Irving, Stan, & Christoff, 2018).

Lack of Control

There is evidence that people can exert *some* control over when they allow their minds to wander. For instance, people mind wander more when task demands are low and divided attention is less detrimental than during difficult tasks that demand their full attention (e.g. Rummel & Boywitt, 2014; Smallwood, Obonsawin, & Reid, 2003)—although newer evidence suggests that this difference is driven largely by intentional mind wandering (Seli, Risko, & Smilek, 2016), and it is plausible that control requires meta-awareness. Since mind wandering probably often *starts* without awareness, control may largely consist of catching mind-wandering episodes early and deciding to redirect attention back to the task at hand or engaging in more deliberate, controlled, non-habitual mind wandering. Thus, in line with what we have proposed before in our discussions of mental efficiency, awareness, and intentionality, the control criterion of automaticity suggests that mind wandering is more habitual at its onset and can then take on a more or less habitual character.

There is some evidence that people can get better at catching their task-unrelated thoughts when they are motivated to do so. In a study using a "bogus pipeline" procedure, which convinced participants that their attentional states including mind wandering were being covertly monitored through physiological measures, Zedelius et al. (2015) offered participants incentives for catching their task-unrelated thoughts during reading. These incentives indeed increased the number of self-catches, without increasing overall mind wandering. However, the fact that most people still spend a substantial amount of time each day engaged in mind wandering—unintentional mind wandering at that—suggests that they either lack the motivation to control their thoughts, or have very limited control over them.

Interestingly, just like the evidence for the controllability of mind wandering is ambiguous, so are people's beliefs, or "lay theories" about controllability. In a series of studies, Zedelius, Protzko, and Schooler, (in preparation; see also Zedelius & Schooler, 2017) have shown that people differ in whether they believe that mind wandering is mostly controllable or largely outside our control. Moreover, these beliefs predicted how much participants reported to mind wander during day-to-day activities and laboratory tasks. Participants who believed that mind wandering is less controllable tended to mind wander more frequently than those who believed that it is controllable, likely because they aren't as motivated to engage in the futile task of trying to regulate their uncontrollable thoughts. This suggests that interventions that aim to reduce habitual mind wandering by training people to be more aware of their thoughts and control unwanted task-unrelated thoughts should also take into account people's beliefs about the capacity to control their thoughts. This may be a key to encouraging deliberate, non-habitual mind wandering.

Individual Differences in Habitual Mind Wandering and Patterns of Thought

Although a lot of attention has been paid to individual differences in *how much* people mind wander, less is known about individual differences that could explain who is more or less prone to *habitual* mind wandering or who shows more habitual patterns of thinking. Research on this question has mostly examined individual differences in people's proclivity for intentional and unintentional mind wandering.

One study recruited college students who as children had been diagnosed with attention-deficit/hyperactivity disorder (ADHD), a disorder characterized by inattention, impulsivity, and problems with inhibiting distraction. The students, compared to control participants who had never been diagnosed, showed higher rates of unintentional mind wandering, but no increase in intentional mind wandering (Shaw & Giambra, 1993). Moreover, ADHD symptoms among healthy college students have also been found to be uniquely associated with unintentional mind wandering (Seli, Smallwood, Cheyne, & Smilek, 2015). Another study examined how mind wandering related to symptoms of obsessive-compulsive disorder (OCD), a disorder characterized by intrusive thoughts. Among healthy college students, more symptoms of OCD were associated with higher rates of unintentional, but not necessarily intentional mind wandering (Seli, Risko, Purdon, & Smilek, 2017). Thus, this research supports the notion that people differ in the extent to which their mind wandering has a more habitual character, at least with regard to occurring unintentionally.

Other research has looked more specifically at the qualities and recurring contents of people's thoughts. This research suggests that, aside from the question of whether or not mind wandering itself is a habit, there can be habitual, repeating patterns in people's thoughts. A recent study by Kane et al. (2017) has examined how differences in personality (specifically, the "big five" personality traits openness, conscientiousness, extraversion, agreeableness, and neuroticism) relate to differences in mind wandering during laboratory tasks and in everyday life settings. They found that, in everyday life settings, participants scoring higher on the trait neuroticism reported less pleasant and more "racing" thoughts, and their mind wandering centered more often around worries or problems. Participants scoring higher on the trait openness mind wandered more about fantasies. Furthermore, participants scoring high on agreeableness reported more pleasant and less strange thoughts, whereas participants who scored higher in extraversion reported more racing and more strange thoughts during everyday life activities. These findings show that a personality can shape a person's spontaneous thoughts both in content and style. Interestingly, our own recent research has shown that mind wandering that is characterized by strange thoughts and fantasies is associated with greater creativity (Zedelius, Protzko, & Schooler, 2017). Thus, it seems that not only do people differ in their patterns of thinking, but some patterns may be more productive than others (see also Zedelius & Schooler, 2016).

Extreme Mind Wandering Habits

An interesting yet very rare phenomenon at the more extreme end of the spectrum of mind wandering experiences is "maladaptive daydreaming". Maladaptive daydreamers seek refuge in daydreams more than others, in extreme cases so excessively that they spend hours at a time engrossed in elaborate and highly structured daydreams and fantasies, often involving recurring characters and stories that play out over years (Bigelsen & Schupak, 2011; Schupak & Rosenthal, 2009).

Maladaptive daydreaming has a similarly habitual (in the sense of being repetitive and uncontrollable) character as rumination, and can have similarly negative consequences. For some, their daydreaming can take up so much time that it prevents them from doing day-to-day chores and pursuing meaningful life goals and social relationships (Bigelsen & Schupak, 2011; Somer, Lehrfeld, Bigelsen, & Jopp, 2016). At the same time, maladaptive daydreamers, unlike ruminators, often experience their daydreams as highly pleasurable and fulfilling. It is an open question whether maladaptive daydreaming is a habit or a compulsion. Correlations with negative health outcomes and obsessive-compulsive thoughts and behaviours suggest that maladaptive daydreaming has some psychopathological properties (Somer et al., 2016). However, researchers have only just begun studying the phenomenon, and more work needs to be done to understand how this tendency develops and to what extent it may resembles a mental habit or a compulsion.

Conclusion and Future Directions

The goal of this chapter was to answer the question, "Is mind wandering a habit?" As we have seen, to answer this question, it is important to acknowledge that mind wandering is a heterogeneous concept. As we have discussed, there are ways in which mind wandering seems to be automatic, and ways in which it is more deliberate. For instance, a person may lose focus of a task and start to mind wander without noticing, without intending to and without any ability to control their thoughts, but might then become aware of the fact that they have lost track and engage in more deliberate, controlled mind wandering. We have also seen that people differ in their tendency to mind wander habitually (i.e. without meta-awareness and intention), and that people experience different recurrent patterns in their thought contents. Thus, it seems that mind wandering does in some ways resemble the kinds of habits—"bad" habits even—we deal with throughout the day. In other ways, mind wandering is much more than a habit, and can entail intentional reveries and creative thought.

With regard to the habitual character of mind wandering, many unanswered questions remain. For instance, a mind wandering episode can be triggered by a vast and diverse number of external and internal cues that in some way evoke personal goals or concerns. An open question is whether mind wandering can also become linked to a much more specific cue. Could a student who copes with a particularly boring class by retreating into her daydreams learn to associate the unfortunate classroom with habitual mind wandering? Experimentally establishing highly specific mind wandering triggers like these could open up valuable avenues for future research. Another interesting question is how people's patterns of mind wandering can be changed. As we have discussed, initial findings show that meta-awareness may reduce the negative impacts mind wandering can have on performance (Franklin, Broadway, et al., 2013; Schooler et al., 2011). Moreover, research suggests that certain patterns in people's thought contents might be associated with positive outcomes. A tendency for strange thoughts and fantasies has been associated with greater openness to experiences (Kane et al., 2017) and greater creativity (Zedelius et al., 2017), and intentional mind wandering has been found to be particularly beneficial for creativity (Agnoli, Vanucci, Pelagatti, & Corazza, 2018). Thus, it would be worthy to further examine how these types of mind wandering can be cultivated over time.

We spend much of our life removed from the here and now, our minds wandering or engaged in daydreams. A large number of these thoughts follow habitual patterns. In many situations, this is a good thing. The spontaneous thoughts that intrude our consciousness often revolve around unfulfilled goals and concerns. While distracting in the moment, these thoughts clearly have some personal value and importance for us, helping us work through problems or plans for future events. However, we can get stuck in habitual patterns of repetitive thoughts, negative thoughts, intrusive thoughts, or unproductive fantasies that can keep us from pursuing more important goals. Understanding and then breaking such habitual thought patterns could open the door to an even richer, more interesting internal world in which we explore more novel or unique thoughts and ideas and realize our unfulfilled goals in a more flexible and agentic manner.

Habit Research in Action: How Can We Change Habitual Patterns of Thought?

We all engage in habitual mind wandering, that is, mind wandering episodes triggered by current concerns or goal discrepancies that unfold automatically, without our awareness and intention and with little control. Moreover, we all occasionally experience periods of mind wandering that are negative or unproductive; we obsess, ruminate, or jump to self-critical conclusions (e.g. Verplanken et al., 2007). When such patterns of thought are triggered repeatedly, they can become habitual (Hertel, 2004; Watkins & Nolen-Hoeksema, 2014). At the individual level, this can lead to an increased risk for depression, anxiety, and even difficulties in physical health (Gotlib & Joormann, 2010; Nolen-Hoeksema, 2000; Watkins, 2008 see also Chap. 15 in this volume). At the societal level, entrenched thought patterns can lead to stereotyping and negative behaviour towards outgroups (see Fox et al., 2016). Thus, can we learn to de-automatize habitual patterns of thought and shift to more constructive and unconstrained mind wandering?

The key to changing habitual patterns of thought is to first notice them. Methods from mind wandering research could be used to do just that. An especially promising technique for this purpose is ESM, which allows researchers to capture repetitive patterns in people's thoughts and to reveal those patterns to individuals. The first stage would be to simply remind people multiple times throughout the day to take note of and report their experience (e.g. through a smartphone application). By asking more detailed questions about what participants are thinking, feeling, and doing at the moment and what the external circumstances are, researchers can identify specific situations in which the individual is most vulnerable to automatic or repetitive, unconstructive thought patterns. These patterns could then be revealed to individuals through feedback at the end of the day or after a longer period of observation. This in itself is a critical step, as research suggests that people can be remarkably unaware of the features or larger patterns in their own inner experience (Fox et al., 2016; Hurlburt, 2011). In a second step, more in-depth procedures can be used to replace or reshape unconstructive habitual thoughts. For instance, guided questions would be used to replace self-critical thoughts with more constructive ones or to break habitual associations between thoughts and emotions. For instance, Kross, Ayduk, and Mischel (2005) found that when individuals are asked to take a distanced perspective on a negative experience and focus on "why" they feel a certain way, rather than "what" they feel, they experience less intense negative emotions.

Another way to change habitual thought patterns that has been proposed by Fox et al. (2016) is through meditation (or similar practices, e.g. hypnosis). A number of studies have shown benefits of mindfulness meditation training for increasing mental control and reducing mind wandering (e.g. Jha et al., 2015; Mrazek, Mooneyham, Mrazek, & Schooler, 2016; Mrazek, Phillips, et al., 2013; Mrazek, Smallwood, & Schooler, 2012; Sedlmeier et al., 2012; Tang & Posner, 2009). Fox et al. (2016) propose that meditation practice may also de-automatize thoughts by breaking learned associations between thoughts in memory and facilitating cognitive-emotional flexibility. This idea is an interesting avenue for future research projects exploring the "middle way" between mind wandering and mindful awareness and attention (Schooler et al., 2014). There is already some evidence that mind wandering can be beneficial for inspiring creative thoughts and ideas (e.g. Baird et al., 2012; Zedelius & Schooler, 2015, 2016). More recent research suggests that this benefit is driven most strongly by intentional mind wandering, and that combined inclinations to frequently intentionally mind wandering while also being able to mindfully focus one's attention on the here and now are most conducive to creativity (Agnoli et al., 2018). Thus, the most constructive and creative types of thinking may indeed arise when we break habitual patterns of thinking and learn to engage in more intentional and controlled yet freely moving and unconstrained (see Mills et al., 2018) mind wandering.

References

Agnoli, S., Vanucci, M., Pelagatti, C., & Corazza, G. E. (2018). Exploring the link between mind wandering, mindfulness, and creativity: A multidimensional approach. *Creativity Research Journal, 30*(1), 41–53.

Antrobus, J. S., Singer, J. L., & Greenberg, S. (1966). Studies in the stream of consciousness: Experimental enhancement and suppression of spontaneous cognitive processes. *Perceptual and Motor Skills, 23*(2), 399–417.

Baars, B. J. (2005). Global workspace theory of consciousness: Toward a cognitive neuroscience of human experience. *Progress in Brain Research, 150*, 45–53.

Baars, B. J. (2010). Spontaneous repetitive thoughts can be adaptive: Postscript on "mind wandering". *Psychological Bulletin, 136*(2), 208–210.

Bargh, J. A. (1994). The four horsemen of automaticity: Awareness, intention, efficiency, and control in social cognition. In R. S. Wyers, Jr., & T. K. Srull (Eds.), *Handbook of social cognition* (2nd ed., pp. 1–40). Hillsdale, NJ: Erlbaum.

Bayer, J. B., & Campbell, S. W. (2012). Texting while driving on automatic: Considering the frequency-independent side of habit. *Computers in Human Behavior, 28*(6), 2083–2090.

Bhangal, S., Allen, A. K., Geisler, M. W., & Morsella, E. (2016). Conscious contents as reflexive processes: Evidence from the habituation of high-level cognitions. *Consciousness and Cognition, 41*, 177–188.

Bigelsen, J., & Schupak, C. (2011). Compulsive fantasy: Proposed evidence of an under-reported syndrome through a systematic study of 90 self-identified non-normative fantasizers. *Consciousness and Cognition, 20*(4), 1634–1648.

Dehaene, S., & Naccache, L. (2001). Towards a cognitive neuroscience of consciousness: Basic evidence and a workspace framework. *Cognition, 79*(1–2), 1–37.

Fox, K. C., Kang, Y., Lifshitz, M., & Christoff, K. (2016). Increasing cognitive-emotional flexibility with meditation and hypnosis: The cognitive neuroscience of de-automatization. In A. Raz & M. Lifshitz (Eds.), *Hypnosis and meditation*. New York, NY: Oxford University Press.

Franklin, M. S., Broadway, J. M., Mrazek, M. D., Smallwood, J., & Schooler, J. W. (2013). Window to the wandering mind: Pupillometry of spontaneous thought while reading. *The Quarterly Journal of Experimental Psychology, 66*(12), 2289–2294.

Franklin, M. S., Mrazek, M. D., Anderson, C. L., Smallwood, J., Kingstone, A., & Schooler, J. W. (2013). The silver lining of a mind in the clouds: Interesting musings are associated with positive mood while mind-wandering. *Frontiers in Psychology, 4*, e583. https://doi.org/10.3389/fpsyg.2013.00583

Giambra, L. M. (1978). Adult male daydreaming across the life span: A replication, further analyses, and tentative norms based upon retrospective reports. *International Journal of Aging and Human Development, 1978*(8), 197–228.

Giambra, L. M. (1995). A laboratory method for investigating influences on switching attention to task-unrelated imagery and thought. *Consciousness and Cognition, 4*(1), 1–21.

Gotlib, I. H., & Joormann, J. (2010). Cognition and depression: Current status and future directions. *Annual Review of Clinical Psychology, 6*, 285–312.

Gyurak, A., Gross, J. J., & Etkin, A. (2011). Explicit and implicit emotion regulation: A dual-process framework. *Cognition and Emotion, 25*(3), 400–412.

Hertel, P. T. (2004). Memory for emotional and non-emotional events in depression: A question of habit. In D. Reisberg & P. Hertel (Eds.), *Memory and emotion* (pp. 186–216). New York: Oxford University Press.

Hurlburt, R. T. (2011). *Investigating pristine inner experience: Moments of truth*. New York, NY: Cambridge University Press.

Jha, A. P., Morrison, A. B., Dainer-Best, J., Parker, S., Rostrup, N., & Stanley, E. A. (2015). Minds "at attention": Mindfulness training curbs attentional lapses in military cohorts. *PLoS One, 10*, e0116889. https://doi.org/10.1371/journal.pone.0116889

Kane, M. J., Brown, L. H., McVay, J. C., Silvia, P. J., Myin-Germeys, I., & Kwapil, T. R. (2007). For whom the mind wanders, and when: An experience-sampling study of working memory and executive control in daily life. *Psychological Science, 18*(7), 614–621.

Kane, M. J., Gross, G. M., Chun, C. A., Smeekens, B. A., Meier, M. E., Silvia, P. J., et al. (2017). For whom the mind wanders, and when, varies across laboratory and daily-life settings. *Psychological Science, 28*(9), 1271–1289.

Killingsworth, M. A., & Gilbert, D. T. (2010). A wandering mind is an unhappy mind. *Science, 330*(6006), 932–932.

Klinger, E., & Cox, W. M. (1987). Dimensions of thought flow in everyday life. *Imagination, Cognition and Personality, 7*(2), 105–128.

Kopp, K., D'Mello, S., & Mills, C. (2015). Influencing the occurrence of mind wandering while reading. *Consciousness and Cognition, 34*, 52–62.

Kross, E., Ayduk, O., & Mischel, W. (2005). When asking "why" does not hurt: Distinguishing rumination from reflective processing of negative emotions. *Psychological Science, 16*(9), 709–715.

Masicampo, E. J., & Baumeister, R. F. (2011). Consider it done! Plan making can eliminate the cognitive effects of unfulfilled goals. *Journal of Personality and Social Psychology, 101*(4), 667.

Mason, M. F., Norton, M. I., Van Horn, J. D., Wegner, D. M., Grafton, S. T., & Macrae, C. N. (2007). Wandering minds: The default network and stimulus-independent thought. *Science, 315*(5810), 393–395.

McMillan, R. L., Kaufman, S. B., & Singer, J. L. (2013). Ode to positive constructive daydreaming. *Frontiers in Psychology, 4*, 626. https://doi.org/10.3389/fpsyg.2013.00626

McVay, J. C., & Kane, M. J. (2010). Does mind wandering reflect executive function or executive failure? Comment on Smallwood and Schooler (2006) and Watkins (2008). *Psychological Bulletin, 136*, 188–197.

McVay, J. C., & Kane, M. J. (2013). Dispatching the wandering mind? Toward a laboratory method for cuing "spontaneous" off-task thought. *Frontiers in Psychology, 4*, 570.

McVay, J. C., Kane, M. J., & Kwapil, T. R. (2009). Tracking the train of thought from the laboratory into everyday life: An experience-sampling study of mind wandering across controlled and ecological contexts. *Psychonomic Bulletin & Review, 16*(5), 857–863.

Merrick, C., Farnia, M., Jantz, T. K., Gazzaley, A., & Morsella, E. (2015). External control of the stream of consciousness: Stimulus-based effects on involuntary thought sequences. *Consciousness and Cognition, 33*, 217–225.

Mills, C., Raffaelli, Q., Irving, Z. C., Stan, D., & Christoff, K. (2018). Is an off-task mind a freely-moving mind? Examining the relationship between different dimensions of thought. *Consciousness and Cognition, 58*, 20–33.

Mooneyham, B. W., & Schooler, J. W. (2013). The costs and benefits of mind-wandering: A review. *Canadian Journal of Experimental Psychology/Revue canadienne de psychologie expérimentale, 67*(1), 11.

Morrison, A. B., Goolsarran, M., Rogers, S. L., & Jha, A. P. (2014). Taming a wandering attention: Short-form mindfulness training in student cohorts. *Frontiers in Human Neuroscience, 7*, 897.

Mrazek, M. D., Franklin, M. S., Phillips, D., Baird, B., & Schooler, J. (2013). Mindfulness training improves working memory and GRE performance while reducing mind-wandering. *Psychological Science, 24*, 776–781.

Mrazek, M. D., Mooneyham, B. W., Mrazek, K. L., & Schooler, J. W. (2016). Pushing the limits: Cognitive, affective, and neural plasticity revealed by an intensive multifaceted intervention. *Frontiers in Human Neuroscience, 10*, e117. https://doi.org/10.3389/fnhum.2016.00117

Mrazek, M. D., Phillips, D. T., Franklin, M. S., Broadway, J. M., & Schooler, J. W. (2013). Young and restless: Validation of the Mind-Wandering Questionnaire (MWQ) reveals disruptive impact of mind-wandering for youth. *Frontiers in Psychology, 4*, 560.

Mrazek, M. D., Smallwood, J., & Schooler, J. W. (2012). Mindfulness and mind-wandering: Finding convergence through opposing constructs. *Emotion, 12*(3), 442.

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

Nolen-Hoeksema, S. (2000). The role of rumination in depressive disorders and mixed anxiety/depressive symptoms. Journal of Abnormal Psychology, 109(3), 504.

Phillips, N. E., Mills, C., D'Mello, S., & Risko, E. F. (2016). On the influence of re-reading on mind wandering. *The Quarterly Journal of Experimental Psychology, 69*(12), 2338–2357.

Quinn, J. M., Pascoe, A., Wood, W., & Neal, D. T. (2010). Can't control yourself? Monitor those bad habits. *Personality and Social Psychology Bulletin, 36*(4), 499–511.

Raichle, M. E., MacLeod, A. M., Snyder, A. Z., Powers, W. J., Gusnard, D. A., & Shulman, G. L. (2001). A default mode of brain function. *Proceedings of the National Academy of Sciences, 98*(2), 676–682.

Rummel, J., & Boywitt, C. D. (2014). Controlling the stream of thought: Working memory capacity predicts adjustment of mind-wandering to situational demands. *Psychonomic Bulletin & Review, 21*(5), 1309–1315.

Schmidt, F. T., & Retelsdorf, J. (2016). A new measure of reading habit: Going beyond behavioral frequency. *Frontiers in Psychology, 7*, 1364.

Schooler, J. W. (2002). Re-representing consciousness: Dissociations between experience and meta-consciousness. *Trends in Cognitive Sciences, 6*(8), 339–344.

Schooler, J. W., Mrazek, M. D., Franklin, M. S., Baird, B., Mooneyham, B. W., Zedelius, C., & Broadway, J. M. (2014). The middle way: Finding the balance between mindfulness and mind-wandering. In *Psychology of learning and motivation* (Vol. 60, pp. 1–33). Academic.

Schooler, J. W., Reichle, E., & Halpern, D. (2004). Zoning out while reading: Evidence for dissociations between experience and metaconsciousness. In D. T. Levin (Ed.), *Thinking and seeing: Visual metacognition in adults and children*. Cambridge, MA: MIT Press.

Schooler, J. W., Smallwood, J., Christoff, K., Handy, T. C., Reichle, E. D., & Sayette, M. A. (2011). Meta-awareness, perceptual decoupling and the wandering mind. *Trends in Cognitive Sciences, 15*(7), 319–326.

Schupak, C., & Rosenthal, J. (2009). Excessive daydreaming: A case history and discussion of mind wandering and high fantasy proneness. *Consciousness and Cognition, 18*, 290–292.

Sedlmeier, P., Eberth, J., Schwarz, M., Zimmermann, D., Haarig, F., Jaeger, S., et al. (2012). The psychological effects of meditation: A meta-analysis. *Psychological Bulletin, 138*(6), 1139–1171.

Seli, P., Carriere, J. S., & Smilek, D. (2015). Not all mind wandering is created equal: Dissociating deliberate from spontaneous mind wandering. *Psychological Research, 79*(5), 750–758.

Seli, P., Kane, M., Smallwood, J., Schacter, D. L., Maillet, D., Schooler, J., & Smilek, D. (2018). Mind-wandering as a natural kind: A family-resemblances view. *Trends in Cognitive Sciences, 22*(6), 479–490.

Seli, P., Risko, E. F., Purdon, C., & Smilek, D. (2017). Intrusive thoughts: Linking spontaneous mind wandering and OCD symptomatology. *Psychological Research, 81*(2), 392–398.

Seli, P., Risko, E. F., & Smilek, D. (2016). On the necessity of distinguishing between unintentional and intentional mind wandering. *Psychological Science, 27*(5), 685–691.

Seli, P., Risko, E. F., Smilek, D., & Schacter, D. L. (2016). Mind-wandering with and without intention. *Trends in Cognitive Sciences, 20*(8), 605–617.

Seli, P., Smallwood, J., Cheyne, J. A., & Smilek, D. (2015). On the relation of mind wandering and ADHD symptomatology. *Psychonomic Bulletin & Review, 22*(3), 629–636.

Shaw, G. A., & Giambra, L. (1993). Task-unrelated thoughts of college students diagnosed as hyperactive in childhood. *Developmental Neuropsychology, 9*(1), 17–30.

Singer, J. L., & Antrobus, J. S. (1970). *Imaginal processes inventory*. Princeton NJ: Educational Testing Service.

Smallwood, J. (2010). Why the global availability of mind wandering necessitates resource competition: Reply to McVay and Kane (2010).

Smallwood, J., McSpadden, M., & Schooler, J. W. (2007). The lights are on but no one's home: Meta-awareness and the decoupling of attention when the mind wanders. *Psychonomic Bulletin & Review, 14*(3), 527–533.
Smallwood, J., McSpadden, M., & Schooler, J. W. (2008). When attention matters: The curious incident of the wandering mind. *Memory and Cognition, 36*(6), 1144–1150.
Smallwood, J., Obonsawin, M., & Reid, H. (2003). The effects of block duration and task demands on the experience of task unrelated thought. *Imagination, Cognition and Personality, 22*, 13–31.
Smallwood, J., & Schooler, J. W. (2006). The restless mind. *Psychological Bulletin, 132*, 946–958.
Somer, E., Lehrfeld, J., Bigelsen, J., & Jopp, D. S. (2016). Development and validation of the Maladaptive Daydreaming Scale (MDS). *Consciousness and Cognition, 39*, 77–91.
Tang, Y. Y., & Posner, M. I. (2009). Attention training and attention state training. *Trends in Cognitive Sciences, 13*(5), 222–227.
Teasdale, J. D., Dritschel, B. H., Taylor, M. J., Proctor, L., Lloyd, C. A., Nimmo-Smith, I., et al. (1995). Stimulus-independent thought depends on central executive resources. *Memory & Cognition, 23*(5), 551–559.
van Vugt, M. K., & Broers, N. (2016). Self-reported stickiness of mind-wandering affects task performance. *Frontiers in Psychology, 7*, Article 732.
Verplanken, B. (2006). Beyond frequency: Habit as mental construct. *British Journal of Social Psychology, 45*(3), 639–656.
Verplanken, B., Friborg, O., Wang, C. E., Trafimow, D., & Woolf, K. (2007). Mental habits: Metacognitive reflection on negative self-thinking. *Journal of Personality and Social Psychology, 92*(3), 526.
Verplanken, B., & Orbell, S. (2003). Reflections on past behavior: A self-report index of habit strength. *Journal of Applied Social Psychology, 33*(6), 1313–1330.
Watkins, E. R. (2008). Constructive and unconstructive repetitive thought. *Psychological Bulletin, 134*(2), 163.
Watkins, E.R., & Nolen-Hoeksema, S. (2014). A habit-goal framework of depressive rumination. Journal of Abnormal Psychology, 123, 24–34.
Zedelius, C. M., Broadway, J. M., & Schooler, J. W. (2015). Motivating meta-awareness of mind wandering: A way to catch the mind in flight? *Consciousness and Cognition, 36*, 44–53.
Zedelius, C. M., Protzko, J., & Schooler, J. W. (2017). *Exploring the relationship between distinct styles of daydreaming and creativity*. Poster presented at the Society for the Neuroscience of Creativity conference, San Francisco, CA.
Zedelius, C. M., & Schooler, J. W. (2015). Mind wandering "Ahas" versus mindful reasoning: Alternative routes to creative solutions. *Frontiers in Psychology, 6*, 834.
Zedelius, C. M., & Schooler, J. W. (2016). The richness of inner experience: Relating styles of daydreaming to creative processes. *Frontiers in Psychology, 6*, 2063.
Zedelius, C. M., & Schooler, J. W. (2017). What are people's lay theories about mind wandering and how do those beliefs affect them? In C. M. Zedelius, B. C. N. Müller, & J. W. Schooler (Eds.), *The Science of Lay Theories: How beliefs shape our cognition, behavior, and health* (pp. 71–93). New York, NY: Springer.

Chapter 21
The Automaticity of Habitual Behaviours: Inconvenient Questions

David Trafimow

There is much agreement that habitual behaviours can be distinguished from other types of behaviours based on automaticity (Verplanken & Orbell, 2003). Habitual behaviours are performed automatically, whereas this is not true of many other types of behaviours. In turn, automaticity has traditionally been assumed to entail four characteristics that do not always coincide with each other (Bargh, 1994): (1) efficiency, in the sense of attentional resources not being used (p. 24); (2) inevitability, in the sense that once the relevant cue has been triggered, the habitual behaviour will follow; (3) habitual behaviour is not intentional; and (4) habitual behaviour is unconscious. For present purposes, the issue of consciousness will be ignored, based on obvious definitional problems (e.g. Chalmers, 1996), and the focus will be on the other three characteristics. The goal is neither to affirm nor contradict that habits work automatically. Rather, the goal is to ask questions from a general philosophical perspective, as opposed to the usual psychological one. The questions will be inconvenient for automaticity as applied to habit.

Resources (Not) Used Up

Probably the most cited characteristic of automaticity is that resources are not used up. Taken literally, this is obviously untrue. The conservation laws of physics are very clear that work cannot be accomplished without using resources (energy). Or, to use the laws of thermodynamics, nothing can be done without generating heat, which again implies that resources are being used. Of course, there is a seemingly easy way out, which is to insist that although everything requires physical resources, habitual behaviours *only* require physical resources, but do not require mental

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resources. This is in contradistinction to many other types of behaviours that require both physical and mental resources. Does distinguishing between physical and mental resources solve the physics problem?

Well, it depends. If one is a dualist, who strongly distinguishes the physical from the non-physical, the distinction works very well. It does not matter if habitual behaviours use up physical resources if they do not use up mental resources, because it is mental resources that are at issue.

But alas, few researchers today are dualists. Contemporary researchers, especially those concerned with brain and mind (Churchland, 1988; Kim, 1995), are likely to insist that what we call non-physical, non-material, or mental, are physical after all. This is because *everything* is physical. Thus, we are left with questions.

- Is it possible to insist on automaticity for habitual behaviours without either (1) violating physics or (2) becoming a dualist?
- If so, how?

The dilemma can be addressed by watering down the insistence that habitual behaviours do not use resources. Suppose the new insistence is merely that habitual behaviours use few resources, rather than zero resources. This new insistence has the double advantage of not requiring that physics be violated and not requiring one to be a dualist. But the double advantage is costly because resource usage becomes continuous, with no clear line between automatic versus controlled processing. And new questions arise.

- If resource use is continuous, have we just invalidated all categorical theories, such as dual-process theories?
- If not, how can categorical theories be saved?
- Does it make sense even to have a category of "habitual behaviours?"
- Does the use of the word "automatic" make sense, if behaviours are going to be assumed to be on a continuous scale with respect to resource use?
- Would it make more sense to have a continuous scale of resources used, rather than to have a scale of resources not used?

Yet another way out might be generated by maintaining that all resources are physical, but with the insistence that there nevertheless are different pools of resources (e.g. Wickens, 1980). In turn, the claim would be that habits use up resources from a pool of resources that differs from the pool or pools of resources used up by other psychologically relevant processes. There is nothing in this position that contradicts physics, forces dualism, or is philosophically problematic, in principle. However, there is still a high cost in psychology terms. Basing the automaticity argument on different pools of resources requires spelling out what the pools are, and distinguishing habitual processes from other psychologically relevant processes with respect to the pools of resources accessed. This is not an easy task and suggests the following questions.

- What are the pools of resources that people have?

- Is there a separate pool of resources that can be used only for habitual processes but not for other ones?
- Is there a separate pool of resources for psychologically relevant processes that are not habitual, that cannot be used for habitual processes?
- How would we distinguish what the different pools of resources are, and which processes draw on which pools?
- Do dual process theories make sense from the point of view of multiple pools of resources?
- If so, how?
- Why has no one provided precise definitions, descriptions, or characterizations of the different resource pools that apply to different processes?[1]

Inevitability

Imagine a habitual behaviour. An undergraduate comes home to her apartment after a tough day attending classes in her physics major, where she is an honors student, and turns on the television. She always turns on the television upon coming home and has done this for years. We might say she is in the *habit* of turning on the television, upon coming home. Upon coming home, it is *inevitable* that she turns on the television. More generally, one characteristic that distinguishes habitual behaviour from other behaviours is the inevitability of habitual behaviour given perception of the triggering cue (e.g. coming home). There has *never* been a time when our undergraduate came home without turning on the television and it will *never* happen in the future?[2]

Of course, the word *never* likely is overstated. It is unlikely, in the extreme, that the habit never is violated, even given the critical cue. We might water down *inevitability*, so that habitual behaviours have an impressive probability of being performed, given the cue, as opposed to insisting that the probability be 100%.

But this comes at a cost. The recent trend has been to consider habits from a social cognition point of view, where behaviours are habitual based on the associations people are theorized to have, and not based on behavioural frequencies (e.g. Verplanken & Orbell, 2003). In fact, this switch from act frequency conceptions to social-cognitive ones, is considered by many researchers to be one of the most important advances in habit research. But this leads to questions.

[1] Of course, it is well known that different parts of the brain have different functions, but this is not the same thing as positing different resource pools, as parts of the brain and resource pools can be considered different levels of analysis.

[2] It is possible that there is a different and overriding goal. For example, our undergraduate might need to study for an upcoming physics examination. In this case, she does not turn on the television and studies instead. It is an interesting question whether a habitual process can count as automatic if there is an overriding goal capable of circumventing it.

- Should we revert to act frequency thinking or at least eliminate inevitability as a criterion for habit?
- If we eliminate inevitability as a criterion, are habits still "automatic?"
- Should we distinguish between habitual *processes*, as non-observational entities that are inevitable; and habitual *behaviours*, which are observable and not inevitable?
- What justification do we have for asserting that habitual processes are inevitable, given an admission that the observable habitual behaviour itself is not inevitable?

Arguably, there are external reasons why a habitual behaviour might not follow, even if the triggering cue is present, and the external issues should not be allowed to count against the notion of inevitability. In the case of our undergraduate, perhaps the phone rings right when she enters her apartment, before she has a chance to turn on the television. Instead of turning on the television, she answers the phone. In this case, it might be unreasonable to consider the phone example to disconfirm inevitability. This argument invokes the notion of the closest possible counterfactual world (Lewis, 1973). If we imagine the closest possible world to the one where the phone rings to prevent our undergraduate from turning on the television, but where the phone does not ring, we might argue that entering the apartment *would have* elicited the behaviour of turning on the television in the closest possible counterfactual world. This argument uses the notion of counterfactual causality (see Paul, 2009 for a comprehensive review). That is, although there may be occasional countervailing factors at specific times, that prevent the cue from eliciting the habitual behaviour, all these can be reconciled with the inevitability notion by claiming that the cue would have elicited the habitual behaviour in the closest possible counterfactual world where the countervailing factor does not occur. This brings up more questions.

- When a countervailing factor prevents the inevitable from happening, can it still be categorized as inevitable?
- If the answer to the foregoing is "yes", what is the justification?
- Does counterfactual inevitability count as real inevitability?
- Because the counterfactual world does not actually happen, is it justifiable for someone to make assertions about it?
- Is a counterfactual view of causation philosophically justifiable?

Perhaps it is possible to marry the counterfactual notion with a change in focus. Instead of focusing on the behaviour, perhaps it is worthwhile to focus on the mental process that leads to the behaviour. In the phone example, perhaps an argument can be made that the undergraduate undergoes the same mental processes as usual, even when the phone rings, with the ringing of the phone cutting off the final part of the process that leads to the television being turned on. The idea here is that the behaviour isn't necessary for inevitability if there is a countervailing factor. Rather, all that is necessary is that there is some sort of mental sequence, with at least part of the sequence happening, even if the rest of the sequence is cut off by the countervailing factor. The argument, then, would be that the rest of the sequence *would have* happened had it not been cut off by the countervailing stimulus. An implicit assumption might be that the fact that some of the sequence happening supports that the rest of the sequence *would have* happened, had it not been cut off by the countervailing stimulus.

- Is it justifiable to take events early in an ostensibly habitual sequence as strong evidence that the rest of the sequence would have happened in the absence of the countervailing stimulus?
- Given that the events early in an ostensibly habitual sequence are mental, and cannot be observed, what justification do psychologists have for insisting that they happen upon perception of the habit eliciting cue?

(Un)Intentionality

Possibly the most philosophically difficult claim implied by automaticity is that habitual behaviours are performed unintentionally. Before going further, inconvenient questions already arise.

- How does one define or characterize "intention" or "intentional?"
- How does one define or characterize "unintentional?"
- Even pretending good definitions or characterizations, is there a continuum going from "unintentional" to "intentional", or do we have a nice dichotomy that would be consistent with dual-process theories?

But let us avoid getting bogged down further by definitional issues, while admitting the wrongness of sidestepping them so completely. Let us consider a personal example of what most would consider an unintentional habitual behaviour. On the way to work, there is a place where I must turn left. I have made the left turn on numerous occasions. It once happened, on this road, that I turned left even though I was not going to work, so turning left was completely inappropriate. According to Heckhausen and Beckmann (1990), this could be termed an action slip. At first blush, this action slip seems like a beautiful piece of evidence for the automaticity of the habitual behaviour, in general; and for the unintentionality of the habitual behaviour, specifically. I meant to go straight but turned left anyhow—out of habit—despite meaning to go straight!

But it is not clear that my behaviour was *unintentional*. Without definitions or characterizations, this is a difficult issue. But let us try to make do anyhow. Whatever an intention is, if we are going to use the concept at all, it seems inescapable that I intended to turn left on the countless occasions where I went to work. Well, then, suppose that on each of these occasions, the intention was stored in memory. The intention to turn left, then, would be frequently represented in memory because of the many occasions on which I intended to go to work, and went to work. There is nothing in the history of social cognition research that invalidates the notion that, upon reaching the crucial intersection, I accessed a frequently represented intention to turn left, and did so. In fact, in the early decades of social cognition research, there was much research supporting that frequently represented cognitions are more accessible than less frequently represented cognitions (see Wyer & Srull, 1989 for a comprehensive review).

Pursuing this line of thinking further, there is an interesting tension between the notion of a frequently represented intention to turn left at the crucial intersection, and the possibility that I had generated a recent intention to go straight on the rare occasion when I was not going to work. In the example, the frequently stored intention won out over the recent intention, but this need not always happen. There also have been times when I meant to go straight at the intersection and did go straight. In these instances, the recent intention won out over the frequent intention. The point for those interested in the unintentionality of habits is that either way, a frequent or recent intention wins out, and it is simply a matter of probabilities which wins out on any occasion.

- If a frequently stored intention wins out, is the behaviour intentional or unintentional?
- If a recently stored intention wins out, is the behaviour intentional or unintentional?
- If the answer to both questions is "intentional", does it make sense to say that habitual behaviours are unintentional?
- More generally, does it make sense to argue about whether habitual behaviours are intentional or not, or does it make more sense to argue about *which* intention is more likely to matter, and when; the frequently stored or recently stored intention?
- If we are to deny that intentions, whether frequent or recent, get stored in memory and can influence later behaviours, then does it make sense to talk about intentions at all?
- And if it does not make sense to talk about intentions at all, then does it make sense to use intentionality to distinguish habitual behaviours from other behaviours?

Arguably, the foregoing example was an action script example rather than a habit example, and consequently does not apply to habit. That is, getting to the crucial corner may simply trigger off the next action, analogous to action scripts in animals that learn to run through mazes. But this argument raises more questions.

- How are habits to be distinguished from action scripts?
- Whatever is used to make the distinction, does it create additional problems?
- Are habits automatic, action scripts automatic, or both automatic?
- If both are alleged automatic, then is the example problematic for habits even if it is more characteristic of action scripts?

As if the foregoing questions were not of enough concern, there are more questions that arise from trying to consider all three automaticity criteria together.

- How well correlated are the three criteria?
- Why has nobody tested the correlations between the three criteria?
- If the correlation is far from perfect, does it make sense to collapse all of them into a single word—*automaticity*?
- Is there a strong theoretical or empirical justification, other than wishful thinking, for placing the three criteria under the single rubric—*automaticity*?

The Strength of Different Kinds of Evidence

The foregoing discussion should render obvious that there are severe problems with all the defining characteristics of automaticity, particularly as applied to habitual processes and habitual behaviours. But what about the evidence? To avoid stepping on anyone's toes, and more importantly to avoid getting bogged down in details idiosyncratic to already performed experiments, I will avoid empirical citations in this section. Rather, I will briefly describe different sorts of evidence in an abstract manner.

Dissociations

Let us consider the ideal case. Suppose a researcher has a "habit" condition and a "no habit" condition, and measures dependent variable A and dependent variable B. The prediction is that dependent variable A is increased by habitual processing that is "automatic", whereas dependent variable B is increased by non-habitual processing that is "controlled". After analyzing the data, the researcher finds that the mean in the automatic condition is greater than the mean in the controlled condition for A, but the reverse is true for B. Thus, we have a beautiful dissociation. Many would take this experiment as providing a strong case for the automaticity of habits? Alternatively, a researcher might expect a difference for one dependent variable and no difference for the other dependent variable, but nevertheless count it as a dissociation that strongly supports the automaticity of habits.

But not so fast! Although dissociations, especially such as the first one, are very flashy, they do not necessarily provide strong evidence. Dunn and Kirsner (1988) provided a general and complex argument pertaining to the evidential strength of dissociative evidence, but it is only necessary here to provide a simple counter example. Imagine that an experimenter has two bowls of liquid water and two bowls of ice. The experimenter also has a room that is 10 °C (well above the freezing point of water) and a room that is −10 °C (well below freezing point of water). The experimenter places one bowl of liquid water and one bowl of ice in each of the two rooms. After the passage of a suitable amount of time, the experimenter notices that the bowl of ice changed to liquid water in the warmer room, whereas the bowl of liquid water changed to ice in the colder room. Thus, where the experiment commenced with a bowl of liquid water and a bowl of ice in both rooms, there is only liquid water in the warmer room and solid ice in the colder room. We have a beautiful dissociation here, just as in habit experiments, but it does not provide a strong case for temperature being a dichotomous variable. Just as dissociations fail to provide strong evidence for temperature as a dichotomous underlying variable, nor do dissociations in the habit literature strongly support that there is an underlying dichotomy with respect to automaticity.

A Lack of an Effect on Behavioural Intentions

The obvious way to support that habits are non-intentional is to perform an "automatic" manipulation that influences the habitual behaviour but that does not influence behavioural intentions. We already have seen that such dissociative evidence fails to strongly support automaticity as a dichotomy. But in this subsection, let us focus specifically on behavioural intentions as the dependent variable. Does a lack of an effect of a manipulation on behavioural intentions provide a strong case that the habitual process is unintentional?

Psychology researchers have had it pounded into them, in graduate school, that null effects fail to provide strong evidence of theoretical notions because there are too many alternative explanations. There might have been too few participants, the manipulation might not have been strong enough, the dependent variable might not have been valid enough, and so on. Although all these are possibilities, they are not the present focus, as null findings nevertheless can matter (Trafimow, 2014). As an example, consider the famous experiment by Michelson and Morley (1887) that some consider to be the most important experiment in the history of science. In the early nineteenth century, physics researchers accepted that the experimental literature strongly disconfirmed Newton's particle theory of light in favor of a wave theory of light (see Einstein & Infeld, 1938 for an excellent account). But there was a snag based on the empirical observation that light reaches Earth from the stars. If light is a wave, and waves need a medium through which to propagate, how can this be? An answer was to assume that the universe is filled with a "luminiferous ether", transparent to ordinary matter, but that provided the medium for light waves to propagate. Thus, light waves propagate through the luminiferous ether to reach the Earth. Michelson and Morley invented an interferometer to detect the luminiferous ether. The details are unimportant here, but what is important is that although they collected thousands of data points, their experiment failed. They were unable to demonstrate the existence of the luminiferous ether. Michelson received a Nobel Prize in 1907.

It is difficult to enumerate all the ways that the "light that failed" was a crucial experiment in the history of physics (Asimov, 1976). Possibly most obviously, without the failure, the famous contraction equation by Lorenz would not have been possible. The idea of the contraction equation is that objects shrink in their direction of motion, depending on their velocity; the greater the velocity, the more the shrinkage. In turn, the contraction equation by Lorenz is an important implication of Einsteinian relativity (Einstein, 1961; Einstein & Infeld, 1938). There can be little doubt that Michelson deserved his Nobel Prize. As an interesting aside, Michelson opposed Einsteinian relativity even though his null findings are believed, today, to support it.

The point of the brief diversion to Michelson was to emphasize that I do not wish to argue against the importance of null findings. Nor do I wish to criticize researchers who wish to make a point of null findings with behavioural intentions as an important dependent variable. But there nevertheless is an important problem with respect to measuring behavioural intentions that needs discussion. To understand the point to be made, a brief discussion of the attitude area is necessary.

Although attitudes have a long history of being touted as the most important concept in social psychology (e.g. Allport, 1935), the fact of the matter is that there is a substantial literature showing that attitudes are poor predictors of behaviours. A famous early study was performed by Lapierre (1934), who found that although hotel and restaurant managers expressed negative attitudes towards letting Chinese people into their establishments, they nevertheless did let in a Chinese couple that were working with Lapierre. Previously expressed attitudes were not consistent with later behaviour. Although the Lapierre study suffers from obvious methodological limitations, researchers continued to perform studies, and continued to find either low or non-existent correlations between attitudes and behaviours. Wicker (1969) famously reviewed the literature and came to a negative conclusion about the ability of attitudes to predict behaviours, which sparked a crisis in social psychology.

Fishbein provided a solution to the crisis by suggesting that perhaps invalid attitude measures explain the poor findings (e.g. Fishbein, 1980; also see Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975, 2010). According to Fishbein, all behaviours have four elements: action, target, time, and context. For example, a person might lift (action) weights (target) every Monday, Wednesday, and Friday morning (time), at the local gym (context). To predict weight lifting, it is invalid to measure "attitudes towards weight lifting" because there is a lack of matching of the attitude measure with respect to the four elements of the behaviour to be predicted. For the attitude measure to be valid, it must match the behaviour to be predicted with respect to the four elements. In the portion of Fishbein's scheme that is relevant to the point to be made here, a key assumption is that behavioural intentions determine behaviours, and, in turn, attitudes are one of the determinants of behavioural intentions. Not only must attitude measures match the behaviours of concern, with respect to the four elements, to be valid; but behavioural intention measures also must match the behaviour of concern, with respect to the four elements, to be valid. Any habit study where there is a failure to have perfect matching of the behavioural intention measure with the behaviour measure, with respect to the four elements, is invalid.

In research dating back to the 1970s, the importance of matching measures of behavioural precursors to measures of behaviours, with respect to the four elements, was tested experimentally by Davidson and Jaccard (e.g. 1979). They manipulated the degree of matching between measures of behavioural precursors and measures of behaviours. Davidson and Jaccard obtained correlations at approximately the .7 level, or higher, when there was perfect matching; but the correlations decreased dramatically, almost to zero, when there was even a single mismatch. Put more generally, even a slight amount of invalidity was sufficient to all but destroy the relations between behavioural precursors and the behaviours themselves.

The importance of having measures of behavioural intentions match measures of behaviours with respect to action, target, time and context, is indisputable. A keen appreciation of this fact of measurement indicates that experiments using measures that fail to live up to this standard are not valid, and the findings cannot be taken seriously. Thus, if a researcher fails to obtain an effect of an experimental manipulation on behavioural intentions for allegedly habitual behaviours, there are at least two potential explanations. First, there is the typical habit researcher's preferred explanation, which is that the habitual behaviour is not under intentional control. Second, there is the measurement explanation, that the behavioural intention measure has little to do with the behaviour of interest because of a lack of matching with respect to action, target, time, and context. Given the dramatic effects on relations between behavioural precursors and behaviours that even slightly invalid measurement of behavioural intentions can cause, the measurement explanation cannot be dismissed. And with the measurement explanation unable to be dismissed, support for the preferred explanation is strongly compromised.

Dissociations Revisited: Null Hypothesis Significance Testing

An important problem in many areas is their dependence on the null hypothesis significance testing (NHST) procedure, a procedure that was widely criticized at the recent American Statistical Association Symposium on Statistical Inference in October of 2017 (see Hubbard, 2016; Ziliak & McCloskey, 2016 for recent reviews). In fact, the NHST was banned at *Basic and Applied Social Psychology* (Trafimow & Marks, 2015; also see 2016). Research on habits is no less vulnerable to NHST limitations than is research in other areas. A full discussion of the issues is beyond present scope (but see Trafimow & Earp, 2017 for a comprehensive discussion). Nevertheless, it is worthwhile to highlight the following problem that comes directly from having a publication bar set at the usual level of $p < .05$. The p-value that a researcher obtains is influenced by two factors: the size of the study (the sample size) and the size of the effect. Because the null hypothesis is rarely exactly true (notwithstanding the Michelson & Morley, 1887 article), it is almost always possible to obtain statistically significant findings merely by having a huge sample size. Thus, obtaining a statistically significant effect may not be very relevant to how much credence a researcher should place in the finding.

But this is only a preliminary problem. A more important problem, from the point of view of intentionality of habits, goes in the opposite direction. That is, researchers typically do not have huge sample sizes. At typical sample sizes, whether an obtained effect is statistically significant depends largely on the sample effect size. The problem is that sample effect sizes, and the *p*-values that depend on them, have distributions, just like any statistic. In fact, under the null hypothesis, *p*-values have a uniform (0, 1) distribution, and it is purely a matter of luck which *p*-value from the distribution of *p*-values one happens to sample. When the null hypothesis is not true, there is still a distribution of *p*-values, with some being under the $p < .05$ threshold, and some not. The researcher may sample a *p*-value that is under the threshold, but also may sample a *p*-value that is above the threshold. Although the *p*-value sampled might not be purely a matter of luck when the null hypothesis is false, luck nevertheless plays an important role. A consequence is that *p*-values are highly subject to statistical regression, sometimes termed regression to the mean. The strong implication is that the fact that a researcher obtains $p < .05$, and can publish the findings, says very little about the *p*-value that would be obtained in a replication study. This is one reason why the Open Science Collaboration (2015) found that well over 60% of research in top journals failed to replicate. Doubtless, there are questionable research practices that contribute too (Bakker, van Dijk, & Wicherts, 2012; John, Loewenstein, & Prelec, 2012; Simmons, Nelson, & Simonsohn, 2011; Woodside, 2016), but the problem of statistical regression is sufficient to produce the problem.

To clarify how much researchers in the habit area should worry about this, Trafimow and de Boer (2018) downloaded the data file that the Open Science Collaboration put on the web, and correlated the *p*-values from the original, published, cohort of studies, with the replication cohort of studies. They obtained the miniscule value of .004. In other words, the *p*-values obtained in the original cohort of studies had almost nothing to do with the *p*-values obtained in the replication cohort of studies. Worse yet, Trafimow and Uhalt (in press) performed computer simulations to show that *p*-values at typical sample sizes are unreliable across samples taken from the same population, even under ideal conditions where all underlying assumptions are met.

Because of the interaction of NHST and statistical regression, it is undeniable that published effect sizes overestimate the effect sizes that would be obtained with many replications where all findings are published. The Open Science Collaboration (2015) found an average effect size of .403 in the original cohort of studies but only .197 in the replication cohort. That researchers are becoming concerned with the inflated effect sizes in the published literature is evidenced by, among other things, a recent discussion on the topic in *Basic and Applied Social Psychology* (Grice, 2017; Hyman, 2017; Kline, 2017; Locascio, 2017a, 2017b; Marks, 2017). Clearly, published effect sizes cannot be trusted because of statistical regression. As a subset of the general psychology literature, published effect sizes on habitual processes also cannot be trusted. The mere fact that the habit area is a subset of psychology, and plays by psychology rules, constitutes an important and underappreciated problem for drawing justified conclusions from research findings.

Mediation

Mediation analyses play an important role in much research on habitual processes. For example, if behavioural intentions or other inconvenient variables do not "mediate" between the independent and dependent variables, researchers conclude that these variables are not important for the process under investigation. Or, if a researcher's hypothesized mediating variable is found to mediate between the independent and dependent variables, researchers conclude that the hypothesized mediator is an important part of the causal chain pertaining to the process under investigation.

Unfortunately, however, mediation analyses have very little to do with real mediation. One way to think about real mediation is to imagine the toppling of a sequence of dominoes: the first domino falling causes the second to fall, the second domino causes the third to fall, and so on (Grice, Cohn, Ramsey, & Chaney, 2015). But in the case of mediation analyses performed on habitual processes, one merely has correlations. It is far from clear that the arrows generated in a mediation analysis have anything to do with causation in the sense of the domino example. To dramatize this point, Trafimow (2015) analyzed the orbits of the planets using mediation analyses to test two hypotheses. One hypothesis was that mass causes velocity causes momentum and energy. The competing hypothesis was that velocity causes mass causes momentum and energy. Trafimow obtained what, by typical mediation analysis standards, would be considered strong support of the latter hypothesis at the expense of the former one. As both hypotheses are blatantly silly, it should be clear that something is wrong with mediation analyses.

The problem, of course, is that one cannot get causation out of correlation. As Spirtes, Glymour, and Scheines (2000) pointed out, when more than one statistical model can account for the finding, there is no way to make a strong case for any one of them; hence, there is a statistical indistinguishability problem. Kline (2015) showed how what seems like a simple mediation analysis is consistent with many potential models. Interestingly, Kline also showed that the problems with mediation analyses are compounded when combined with the use of NHST to decide what pathways to believe or not believe. More generally, there is a growing literature on the fallacies that come with using mediation analyses to test models (Grice et al., 2015; Kline, 2015; Tate, 2015; Thoemmes, 2015; Trafimow, 2015, 2017). Trafimow (2017) even showed that most mediation models (and causal models more generally if based on correlations) must be wrong simply based on how probability works. To understand the argument quickly, consider again that most mediation analyses are based on underlying correlations. Well, then, a correlation might exist for what, according to the model, is a good reason, but it also might exist for a bad reason. For example, consider a simple model specifying that X is a cause of Y. A correlation between X and Y could be because the model is true (a "good" reason), but it also could be for other reasons, such as that Y is a cause of X, or because an outside variable is a cause of both X and Y. From the point of view of the model, these are "bad" reasons for the correlation. In the simple case where X is hypothesized to cause Y, there might be a reasonable chance that the correlation is for a good reason, as opposed to a bad reason. But suppose that there are three variables in the model, so that there are three underlying correlations. Now all three correlations must be for a good reason for the model to be true. Even if we generously assign a value of .7 to the probability of each correlation being for a good reason, the probability of all three correlations existing for good reasons is $.7 \times .7 \times .7 = .343$, substantially less than a coin toss. And matters continue to worsen as the causal model becomes more complex. When there are four variables, there are six underlying correlations, and again commencing with a base value of .7, the probability of all six correlations being for good reasons is $.7 \times .7 \times .7 \times .7 \times .7 \times .7 = .12$. In summary, although it sounds harsh to say, all the studies that have made use of mediation analyses to support important hypothesized causal pathways, or disconfirm them, fail to do so.

Where Should Researchers Concerned with Habitual Processes Go from Here?

Although we have just seen that the research methods that researchers in the habit area use are limited in various ways, that is not the most important problem. The most important problem is to derive new notions of habitual processes that are neither act frequency accounts nor accounts that depend on the notion of automaticity. There are other possibilities that researchers should explore. For example, researchers could attempt to build a theory on the notion of the accessibility of intentions to perform behaviours. The more accessible the behavioural intention, the more the person can be said to have the habit. Obviously, this idea directly contradicts the dual-process way many researchers approach habits. But approaching habit from the point of view of intention accessibility suggests empirically researchable questions such as the following.

- What factors make behavioural intentions more, or less, accessible, and in what contexts?
- How stable, across different contexts, is behavioural intention accessibility?
- How should intentional behaviour be distinguished from accidental behaviour?
- Because highly accessible behavioural intentions need little consideration for action, might there be a negative relationship between the accessibility of behavioural intentions and the clarity with which people can state them?

Or, for those researchers who dislike using behavioural intentions, another possibility is to consider habits from an affective perspective. Going back to basics, why do people perform behaviours on what seems to be a habitual basis? An obvious possibility is that it feels good to do so, or at least people associate the behaviour with positive affect. Or, perhaps people associate not performing the behaviour with negative affect. Thus, researchers might consider an affective account of habitual processes. This approach also suggests empirically researchable questions.

- What is more important, positive affect associated with the behaviour or negative affect associated with not performing the behaviour?
- Positive or negative affect are rather vague terms: what kinds of positive or negative affect, or what combinations of these kinds, are important?
- How does affect, whether positive or negative, interact with cognitive processes to influence habits?

Yet another possibility is to take seriously, as many habit researchers already do, the strength of association between the triggering cue and the behaviour it elicits. The stronger the association, the more habitual the behaviour. From this perspective, researchers might usefully investigate the strength of association between various cues and various behaviours. Furthermore, there are conceptual questions that require some deep thinking, as well as empirically researchable questions. Conceptual questions might be as follows.

- How does one define associative strength?
- How does one measure associative strength?
- If different habits have different associative strengths, where is the justification for dual-process habit theories?
- If habit simply reduces to associative strength, why bother using the word *habit* at all?

Given answers to the conceptual questions, empirical questions might be as follows.

- How stable is associative strength?
- Might different cues elicit the behaviour with different associative strengths?
- If there is more than one cue, might the associative strength measured with respect to one cue differentially influence dependent variables relative to associative strength measured in the context of multiple cues?
- If different habits have different associative strengths, how easily can researchers perform experimental manipulations to increase or decrease the associative strengths?
- It is easy and traditional to think about the accessibility of the cue as separate from the associative strength between the cue and the behaviour, but is it possible that these are not separate? That is, might the way in which a cue is accessed influence the strength of association between it and the behaviour?

Conclusion

It is a cliché that, in science, questions often are more important than answers. The present chapter was written in that spirit. There has been a long history of researchers accepting, without sufficient consideration, the automatic nature of habits. Researchers should ask many more questions before such acceptance. I hope and expect that the present focus on questions will help to remedy this lack.

Habit Research in Action

Claims about a lack of relationship between intentions and habitual behaviours are limited by a lack of correspondence between intention and behaviour measures, the use of between-participants analyses for a within-participants proposal, multi-point intention measures paired with binary behaviour measures, and lack of variance for variables pertaining to habitual behaviours.

These limitations can be overcome by a study, with appropriate follow-ups with different paradigms. Imagine participants were asked binary questions about a variety of behaviours, such as exercise. After defining what is meant by "habit", questions might be, "Are you in the habit of exercising every Tuesday morning?" and "Are you in the habit of doing something other than exercising every Tuesday evening?" These questions can be reversed: "Are you in the habit of exercising every Tuesday evening?" and "Are you in the habit of doing something other than exercising every Tuesday morning?" Depending on binary answers ("yes" or "no"), it should be possible to obtain participants that are in the habit of exercising on Tuesday mornings and doing something else on Tuesday evenings; exercising on Tuesday evenings and doing something else on Tuesday mornings; or neither category.

With participants' habits or lack thereof established, participants can be asked intention questions on Monday. For example, "Do you intend or not intend to exercise Tuesday morning (evening)?" And on Wednesday, they could be asked, "Did you exercise or not on Tuesday morning (evening)?"

For predictions, consider participants who intend to exercise either Tuesday morning or Tuesday evening (and not to exercise at the other time). If intentions are highly related to behaviours, regardless of habits, then there should be many matches between intention responses and later behaviour responses, even for habitual behaviours. For example, participants who are in the habit of exercising on Tuesday mornings and doing something else on Tuesday evenings should intend to exercise on Tuesday morning and not on Tuesday evening; and should exercise on Tuesday morning and not on Tuesday evening. Analogously, participants who are in the habit of exercising on Tuesday evenings and doing something else on Tuesday mornings should intend to exercise on Tuesday evening and not on Tuesday morning; and should exercise on Tuesday evening and not on Tuesday morning. In contrast, according to the literature about a lack of such a relationship, such matching should not occur at much greater than chance levels for participants in the habit whereas it should for participants not in a relevant habit. Advantages of the proposed paradigm are that the measures are correspondent; the matching of responses to intentions and behaviours can be assessed for each participant, and the frequency of participants who support or disconfirm hypotheses can be assessed; all measures are binary so there is correspondence between intentions and behaviours with respect to response options; and the paradigm is structured to produce much variance in intentions and behaviours, within-participants. My bet is that intentions and behaviours will go well together, even for habitual behaviours.

References

Ajzen, I., & Fishbein, M. (1980). *Understanding attitudes and predicting social behavior*. Englewood Cliffs, NJ: Prentice-Hall.

Allport, G. (1935). Attitudes. In C. Murchison (Ed.), *A handbook of social psychology* (pp. 789–844). Worcester, MA: Clark University Press.

Asimov, I. (1976). *Asimov on physics*. New York: Avon Books.

Bakker, M., van Dijk, A., & Wicherts, J. M. (2012). The rules of the game called psychological science. *Perspectives on Psychological Science, 7*(6), 543–554. https://doi.org/10.1177/1745691612459060

Bargh, J. A. (1994). The four horsemen of automaticity: Awareness, intention, efficiency and control in social cognition. In R. S. Wyer & T. K. Srull (Eds.), *Handbook of social cognition* (Vol. 1, pp. 1–40). Hillsdale, NJ: Erlbaum.

Chalmers, D. J. (1996). *The conscious mind: In search of a fundamental theory*. Oxford: Oxford University Press.

Churchland, P. (1988). *Matter and consciousness* (Rev. ed.). Cambridge, MA: MIT Press.

Davidson, A. R., & Jaccard, J. J. (1979). Variables that moderate the attitude-behavior relation: Results of a longitudinal survey. *Journal of Personality and Social Psychology, 37*, 1364–1376.

Dunn, J., & Kirsner, K. (1988). Discovering functionally independent mental processes: The principle of reversed association. *Psychological Review, 95*, 91–101.

Einstein, A. (1961). *Relativity: The special and the general theory (Robert W. Lawson, Trans.)*. New York: Crown Publishers.

Einstein, A., & Infeld, L. (1938). *The evolution of physics: From early concepts to relativity and quanta*. New York: Simon & Schuster.

Fishbein, M. (1980). A theory of reasoned action: Some applications and implications. In H. E. Howe (Ed.), *1979 Nebraska symposium on motivation* (pp. 65–116). Lincoln, NE: University of Nebraska Press.

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

Fishbein, M., & Ajzen, I. (2010). *Predicting and changing behavior: The reasoned action approach*. New York: Psychology Press, Taylor & Francis Group.

Grice, J. W. (2017). Comment on Locascio's results blind manuscript evaluation proposal. *Basic and Applied Social Psychology, 39*(5), 254–255. https://doi.org/10.1080/01973533.2017.1352505

Grice, J. W., Cohn, A., Ramsey, R. R., & Chaney, J. M. (2015). On muddled reasoning and mediation modeling. *Basic and Applied Social Psychology, 37*, 214–225. https://doi.org/10.1080/01973533.2015.1049350

Heckhausen, H., & Beckmann, J. (1990). Intentional action and action slips. *Psychological Review, 97*(1), 36–48. https://doi.org/10.1037/0033-295X.97.1.36

Hubbard, R. (2016). *Corrupt research: The case for reconceptualizing empirical management and social science*. Los Angeles, CA: Sage Publications.

Hyman, M. (2017). Can 'results blind manuscript evaluation' assuage 'publication bias'? *Basic and Applied Social Psychology, 39*(5), 247–251. https://doi.org/10.1080/01973533.2017.1350581

John, L. K., Loewenstein, G., & Prelec, D. (2012). Measuring the prevalence of questionable research practices with incentives for truth telling. *Psychological Science, 23*(5), 524–532. https://doi.org/10.1177/0956797611430953

Kim, J. (1995). Mind–body problem. In T. Honderich (Ed.), *Oxford companion to philosophy*. Oxford: Oxford University Press.

Kline, R. B. (2015). The mediation myth. *Basic and Applied Social Psychology, 37*, 202–213. https://doi.org/10.1080/01973533.2015.1049349

Kline, R. (2017). Comment on Locascio, results blind science publishing. *Basic and Applied Social Psychology, 39*(5), 256–257. https://doi.org/10.1080/01973533.2017.1355308

Lapiere, R. T. (1934). Attitudes vs. actions. *Social Forces, 13*(2), 230–237. http://www.jstor.org/stable/2570339

Lewis, D. (1973). *Counterfactuals*. Oxford: Basil Blackwell.

Locascio, J. (2017a). Results blind publishing. *Basic and Applied Social Psychology, 39*(5), 239–246. https://doi.org/10.1080/01973533.2017.1336093
Locascio, J. (2017b). Rejoinder to responses to “results blind publishing”. *Basic and Applied Social Psychology, 39*(5), 258–261. https://doi.org/10.1080/01973533.2017.1356305
Marks, M. J. (2017). Commentary on Locascio 2017. *Basic and Applied Social Psychology, 39*(5), 252–253. https://doi.org/10.1080/01973533.2017.1350580
Michelson, A. A., & Morley, E. W. (1887). On the relative motion of earth and luminiferous ether. *American Journal of Science, Third Series, 34*(203), 233–245. http://history.aip.org/exhibits/gap/PDF/michelson.pdf
Open Science Collaboration. (2015). Estimating the reproducibility of psychological science. *Science, 349*(6251), aac4716. https://doi.org/10.1126/science.aac4716
Paul, L. A. (2009). Counterfactual theories. In H. Beebee, C. Hitchcock, & P. Menzies (Eds.), *The Oxford handbook of causation* (pp. 158–184). New York: Oxford University Press.
Simmons, J. P., Nelson, L. D., & Simonsohn, U. (2011). False-positive psychology: Undisclosed flexibility in data collection and analysis allows presenting anything as significant. *Psychological Science, 22*(11), 1359–1366. https://doi.org/10.1177/0956797611417632
Spirtes, P., Glymour, C., & Scheines, R. (2000). *Causation, prediction, and search*. Cambridge, MA: MIT Press.
Tate, C. U. (2015). On the overuse and misuse of mediation analysis: It may be a matter of timing. *Basic and Applied Social Psychology, 37*, 235–246. https://doi.org/10.1080/01973533.2015.1062380
Thoemmes, F. (2015). Reversing arrows in mediation models does not distinguish plausible models. *Basic and Applied Social Psychology, 37*, 226–234. https://doi.org/10.1080/01973533.2015.1049351
Trafimow, D. (2014). Editorial. *Basic and Applied Social Psychology, 36*(1), 1–2. https://doi.org/10.1080/01973533.2014.865505
Trafimow, D. (2015). Introduction to special issue: What if planetary scientists used mediation analysis to infer causation? *Basic and Applied Social Psychology, 37*(4), 197–201. http://dx.doi.org/10.1080/01973533.2015.1064290
Trafimow, D. (2017). The probability of simple versus complex causal models in causal analyses. *Behavior Research Methods, 49*(2), 739–746. http://dx.doi.org/10.3758/s13428-016-0731-3
Trafimow, D., & Earp, B. D. (2017). Null hypothesis significance testing and Type I error: The domain problem. *New Ideas in Psychology, 45*(1), 19–27. http://dx.doi.org/10.1016/j.newideapsych.2017.01.002
Trafimow, D., & de Boer, M. (2018). *Measuring the strength of the evidence*. Under submission.
Trafimow, D., & Marks, M. (2015). Editorial. *Basic and Applied Social Psychology, 37*(1), 1–2. https://doi.org/10.1080/01973533.2015.1012991
Trafimow, D., & Marks, M. (2016). Editorial. *Basic and Applied Social Psychology, 38*(1), 1–2. https://doi.org/10.1080/01973533.2016.1141030
Trafimow, D., & Uhalt, J. (in press). Do p-values measure anything? *American Journal of Social Science Research*.
Verplanken, B., & Orbell, S. (2003). Reflections on past behaviour: A self-report index of habit strength. *Journal of Applied Social Psychology, 33*, 1313–1330.
Wickens, C. D. (1980). The structure of attentional resources. In R. Nickerson (Ed.), *Attention and performance* (Vol. VIII, pp. 239–257). Hillsdale: Lawrence Erlbaum.
Wicker, A. W. (1969). Attitudes versus actions: The relationship of verbal and overt behavioral responses to attitude objects. *Journal of Social Issues, 25*(4), 41–78. https://www.thecre.com/tpsac/wp-content/uploads/2011/02/Appendix1_AttitudevsAction_ByWicker1969.pdf
Woodside, A. (2016). The good practices manifesto: Overcoming bad practices pervasive in current research in business. *Journal of Business Research, 69*(2), 365–381. https://doi.org/10.1016/j.jbusres.2015.09.008
Wyer, R. S., & Srull, T. K. (1989). *Memory and cognition in its social context*. Hillsdale: Lawrence Erlbaum Associates, Incorporated.
Ziliak, S. T., & McCloskey, D. N. (2016). *The cult of statistical significance: How the standard error costs us jobs, justice, and lives*. Ann Arbor, MI: The University of Michigan Press.

Chapter 22
Progress and Prospects in Habit Research

Sheina Orbell and Bas Verplanken

The renewed vigour with which the concept of habit, and habit antecedents, mechanisms and consequences are being studied is demonstrated by the diverse topics brought together in this volume. In this concluding chapter, we reflect upon progress and prospects in relation to three issues that are at the centre of habit theorising and research; the relationship of habit to goals and motivation, the measurement of habit and the relationship of habit to constructs of willpower and self-control.

Motivation and Habit

The relationship of goals and motivational processes to the development, maintenance and undoing of habits is perhaps one of the most debated issues throughout the chapters presented in the book. These issues might be summarised as concerning: (a) Is motivation necessary for the development and execution of habit? (b) Is goal independence a defining feature of habit? (c) Are goals necessary to suppress habits?

Is motivation necessary for development of habit? Evidence for habitual control of behaviour in everyday life comes largely from longitudinal (correlational) studies of extant behaviours in which the impact of intention on behaviour is attenuated in circumstances where an individual has repeatedly performed behaviour in stable contexts in the past (Ouellette & Wood, 1998). This relationship has not been consistently observed, and recent analyses suggest that the relationship of intention to

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behaviour might be better viewed as quadratic, such that initially, intention is a relatively weak predictor of a novel behaviour (cf. Orbell & Sheeran, 1998), acquires improved predictive ability over time as a consequence of increased intention stability/strength and then reduces in predictive ability as the behaviour is repeated in a stable context and acquires the characteristics of habit (Sheeran, Godin, Conner, & Germain, 2017, but see also Chap. 21 in this volume). Habit discontinuity studies of naturally occurring context changes find that participants continue to act in line with goals, so long as they continue to live in the same context (Verplanken, Walker, Davis, & Jurasek, 2008; Wood, Tam, & Witt, 2005; see also Chap. 11 in this volume). The inference is that habits develop as a consequence of intended behaviour in the past that has been repeatedly performed in stable cue contexts. Once formed, habits are performed with limited active influence from motivations. Animal learning research similarly employs reward paradigms in order to build habits; specifically, in animal studies extended training at a task such as maze running or lever pushing for a reward produces habitual behaviour that persists even after the reward is devalued (i.e. the animal is satiated or the food is rendered unpleasant) (Adams, 1982). Indeed it might be argued that all experimental manipulations of habit require participants to pursue a goal, even if that goal is merely to follow experimenter instructions in order to complete the experiment and obtain credit. However, habits can be acquired in everyday life by accidental but consistent pairing of action with context (Skinner, 1938) and some recent experimental paradigms have trained habits to cues via an incidental pairing of cues (e.g. Lin, Wood, & Monterosso, 2016). In some circumstances that are prime candidates for habit formation interventions, it is precisely the lack of motivation that necessitates the formation of a habit. For example, patients with serious yet asymptomatic conditions requiring routine medication fail to adhere because they do not feel unwell. Lack of symptoms undermines motivation to medicate in a prophylactic manner (Orbell & Phillips, in press). Passing action control to habit cues may bypass this difficulty.

The true relationship of habit to declarative intention may also be obscured by evidence that people make goal inferences for their habits. Adriaanse, Kroese, Weijers, Gollwitzer, and Oettingen (2018) provide preliminary evidence that people confabulate (make up reasons for their unexplained behaviour without intent to deceive and without knowing that the claim is ill-grounded) when induced to behave, without conscious awareness, in ways that are inconsistent with current goals or values. Because habits operate by mechanisms of which an individual may be unaware, and people may be unaware of the cues that trigger behaviour, people have a tendency to own their habits, particularly their positive habits and to describe them as intentional (e.g. Wood & Rünger, 2016; see also Chap. 2 this volume).

Habits may form as a consequence of goal intentions, or be consistent with goals in the past. They may also be misattributed to goals. In this case, measures of habit that reply upon self-reports may in fact underestimate the extent to which behaviour is controlled by cue–response associations in memory. Inference may also stretch to instances where an undesired habit, such as eating chocolate biscuits when watching television is cued and runs off smoothly, in contradiction to an intention to diet (e.g. Verplanken & Faes, 1999). In these instances, lack of access to the cue contingency might lead an individual to incorrectly infer some other cause such as stress at work and consequently fail to gain traction on his actual food habit cues.

Is goal independence a defining feature of habit? Contemporary accounts of habit in neuroscience research show that brain systems activated during performance of cue–response habits is localized in the sensorimotor loop, whereas control of goal-directed actions is localized in brain regions in the associative loop (e.g. Tricomi, Balleine, & O'Doherty, 2009; Yin & Knowlton, 2006). Thus, while habit formation may originate in activation of networks concerned with planning and executive function and goal-directed behaviour, neural activity shifts from these networks to those concerned with performance, and behaviour becomes 'locked in'. Importantly, these different neural networks associated with goal-directed and habit behaviour operate in competition, so that during habit performance, goal based systems are suppressed. This idea, that habit performance relies upon specific behaviours brought to mind by cues, which may include previous actions in a behavioural script sequence, stands in contrast to the ways in which attitudes and goals guide behaviour. Even automatic goal pursuit, in which goals are activated and guide behaviour outside of conscious awareness, can produce a range of possible actions associated with the goal. While experiments in this field may examine a specific behavioural outcome of interest, nonetheless an alternative behavioural outcome might have been equally substituted to demonstrate the same process of goal pursuit. Additionally, implicit goals become inactive once satisfied (Aarts, 2007), whereas habits will run on following satiety or devaluation. Habits contrast with this flexible pattern of responding characterised by motives. In an experiment that demonstrated the independence of motives and habit, Neal, Wood, Wu, and Kurlander (2011) manipulated both motive to eat popcorn (fresh vs. stale) and popcorn eating context (cinema vs. meeting room) while participants with strong and weak cinema popcorn eating habits ostensibly rated film clips. Participants with strong popcorn eating habits ate just as much of the stale as the fresh popcorn, but only when in the cinema context. Thus, habitual behaviour persisted in conflict with a devalued attitude toward popcorn *when* the habit context cue was present, but not in a different cue context. Similarly, changes in monetary incentives failed to change response habits in a game, so that people continued to make a habitual choice even though it was no longer rewarded (Gillan, Otto, Phelps, & Daw, 2015). Eating a food to satiety did not deter participants from choosing that food when it was their habitual choice (Tricomi et al., 2009). Trafimow (Chap. 21, this volume) also wonders if his action slip in the form of an accidental driving left turn while not intending to go to work might be due to priming (by perception of the junction) of an implicit goal to get to work. Neal, Wood, Labrecque, and Lally (2012) showed that people with strong habits do not have speeded response latency to primed motives they *believe* guide their actions. Trafimow's desire for a purposeful explanation of his mistake, may lead to confabulation of a logical reason, as opposed to recognition that this turn was merely one in a sequence that makes up the behavioural script for driving to work. Once the script was initiated, it continued, perhaps because he gets into his car and begins a certain route sequence most repeatedly when driving to work.

While many habits are single acts, or repeated single acts (eating popcorn, crisps, biscuits, cigarette smoking), many are behavioural scripts involving multiple actions, each cued by the previous action. Once the sequence has begun, it will run on. Behavioural scripts are overlearned habit sequences. They characterize many features of daily life, including not only the routes we take frequently, but skills we possess such as making a cup of coffee, dressing ourselves, making sushi, or behaviours that are prescribed by our social environment or culture (e.g. Abelson, 1981). These scripts are outside of our conscious awareness, we may not be able to consciously articulate the steps they comprise without great difficulty, yet we perform them automatically. If they are interrupted—consider for example being stopped halfway up the staircase at home—we sometimes have difficulty reinstating them after they become conscious, and may find it easier to return to the bottom and start again because the number of motor actions required to climb a flight of stairs is so habituated that stopping at the top is automatic, and rarely involves an extra false step, or trip. This scripted nature of habits confirmed by neuroscience, is particularly helpful in times of stress—consider a rabbit returning to a warren when under threat, or a soldier following orders, or undertaking a sequence of actions to arm his gun whilst under fire. The distinction between instigation and execution habit suggested by some authors may be a false dichotomy (Phillips & Gardner, 2016). Whether an individual 'ought to' jog down the street or drive to work without conscious awareness is not the point. The point is that people often do. Who would wish to admit that he or she just arrived at work and parked but does not recall the journey? If jogging on the street is always accompanied by conscious control—car drivers would not need to be on high alert for joggers who show no awareness of what is going on around them and who are often wearing headphones, or even speaking on a headset phone. Interestingly, gyms are often walled with mirrors. Their purpose might be to correctly execute exercises, but social psychological research tells us that self-awareness is promoted by mirrors in the environment and can facilitate conscious control of action (Dijksterhuis & van Knippenberg, 2000).

Are goals necessary to suppress habits? Evidence that habits and goal-directed behaviour are controlled by different neural networks poses a fundamental difficulty for undoing habits (Graybiel & Smith, 2014), because it seems that the 'imprinted' cue–response associations and scripts associated with established habits cannot be undone. Anecdotally, many an ex-smoker, even one who ceased smoking 20 years previously, and experiences no cue prompted desires to smoke in almost all contexts, can still experience the impulse to smoke in certain cue contexts, when seriously ego depleted, or even in dreams. A single lapse, or enactment of the cue–response association, can quickly re-establish the habit. A great deal of research across multiple behaviour types, shows that merely implementing interventions to modify attitudes or intentions, is relatively ineffective in changing habit behaviour (e.g. Webb & Sheeran, 2006). For example, persuasive appeals that changed preferences for soft drinks failed to change the drink choices of people with strong soft-drink habits (Itzchakov, Uziel, & Wood, 2018). Habits are a powerful source of behavioural change resistance.

On the face of it, constant and demanding goal self-regulation, that is itself ego depleting, may be required to combat strong habits. One approach proposed to support goals that are counter-habitual is the formation of implementation intentions (Gollwitzer, 1993, 1999). Implementation intentions are consciously implemented goal-directed self-regulatory strategies that supplement goal intentions ('I intend to do Z'). They take the form 'If I encounter context/cue X then I will perform behaviour Y' in the service of the goal-directed behaviour. These if-then plans link context opportunities to action so that opportunity to act is not missed. In the context of overcoming habits, so long as an individual can correctly identify the existing cue for his or her unwanted behaviour, it may be possible to form an implementation intention to replace an unwanted habit (eating crisps when watching television) with a plan to eat fruit when watching television, for example. Studies that have explored the utility of these strategies for overcoming habits show limited evidence of effectiveness, in part because a plan to respond to a cue in a different manner than prescribed by habit creates an opportunity for conscious control of action but does not make the novel response more accessible than the old one (Adriaanse, Gollwitzer, De Ridder, de Wit, & Kroese, 2011; see also Chap. 10 this volume). Plans to respond by attempting to negate a habit cue–response ('If I encounter stimulus X I will tell myself not to do Y') either reactivate prior associations between cue and response Y, or maintain perceptual readiness to perceive a habit cue. Plans to ignore cues ('If I encounter cue X I will ignore it') may be more effective in breaking habits, but little research has been conducted in samples where evidence has been provided of prior strong habits, or with adequate follow up to substantiate effects.

Habit reversal theory (Azrin & Nunn, 1973) developed to treat habits such as hair pulling, nail biting and skin picking suggests a number of strategies that, together have clinical effectiveness (see also Chap. 9 this volume). Strategies include development of cue and response awareness via monitoring, and description, and detection of early signs that a response is occurring, training an incompatible response and enhancing motivation for behaviour change.

A novel approach might be afforded by training new habits that rely less on the mobilization of conscious goal regulation, but employ habit architecture to acquire new habits. Just as research is beginning to suggest ways in which environmental primes might be employed to create 'choice architecture' that nudges people to enact their goals (e.g. Marteau, Hollands, & Kelly, 2015), so 'habit architecture' may be employed to nudge people to enact new habits. A new habit can simply override an old one. For example, developing a new habit to go to the gym after work can effectively inhibit the old habit of going to the pub after work. Or a new habit of walking to work can effectively inhibit an old habit of driving to work. Habit discontinuity theory takes a different approach that relies upon context change. Because habit is context dependent, changing contexts serve to disrupt habit and create opportunity for change (e.g. Verplanken et al., 2008; Verplanken & Roy, 2016; Verplanken & Wood, 2006; see also Chap. 11 this volume).

Progress and Prospects in Habit Measurement

Habit crosses interdisciplinary boundaries perhaps more so than any other psychological phenomenon, and habit research employs a wide range of methodologies and research paradigms. This breadth has enriched the field and convergent evidence across disciplines leads to the conclusion that habit cannot be ignored. Habits exist and can be identified in specific patterns of brain activity, in evidence of associations in memory, in action slips made in a cue context when goals are in opposition, and in the experience of having acted without realising or intending it. Table 22.1 summarises these various approaches to identifying habit that are discussed in this book and elsewhere in the literature. We take stock on the adequacy of current methods and consider how research efforts might be progressed.

Measures developed for different purposes possess different qualities. In other words, different measurement types reveal different slices of a habit reality. There is no single paradigm or method by which to assess the existence of a strong habit and in some ways habit theory has advanced beyond current measures. Research that seeks to evidence habit mechanism relies upon establishing a strong cue–response association in memory or manipulates the association via training. Behavioural slip paradigms evidence habit when counter-intentional behaviour occurs in the presence of a cue. Neuroscience paradigms evidence habit via concurrent activation of brain regions concerned with motor, rather than reflective goal and planning related functions. Self-report measures either represent the conditions conducive to habit formation (high past behavioural frequency in a particular context) or the experience of habit.

Relatively little research has examined the co-occurrence of these measures. For instance, Galla and Duckworth (2015) reported a 0.53 correlation between the Frequency-in-Context measure (e.g. Ji & Wood, 2007) and the Self-Report Habit Index (Verplanken & Orbell, 2003). The Self-Report Habit Index is also correlated with the Response Frequency measure (Verplanken, Aarts, van Knippenberg, & van Knippenberg, 1994), attentional bias to habit cues consistent with perceptual readiness to detect habit cues, and longitudinally to behavioural slips in context after response devaluation (Orbell & Verplanken, 2010). Frequency–in-Context correlated significantly with speeded response latency in identifying habits following context primes (Neal et al., 2012).

No measure of self-reported habit has been directly validated against external evidence of efficiency, non-intentionality, unawareness, and uncontrollability (Bargh, 1994). However, self-reported lack of awareness is relied upon in a good deal of priming research concerning non-conscious activation, albeit in conjunction with minimal stimulus exposure times that are preconscious (Bargh & Chartrand, 2014). As a consequence, it cannot be concluded with confidence that self-report measures do not tap a sense of fluency and ease of performance, as opposed to habit or, when a history of repetition is not assessed, ease of goal-directed activity. Paradigms employing response devaluation may fail to distinguish between habitual control of action and deficits of goal-directed control because slips may occur as

Table 22.1 Habit measures

Measures based on observations	Definition and example
Behaviour observations	In situ observations of behaviour. Studies using behaviour observations implicitly or explicitly equate habit and behavioural repetition. For example, studies on interventions to promote handwashing aim at establishing handwashing habits, which may be assessed by observing the behaviour (e.g. George et al., 2017)
Response latency paradigms	An implicit measure that infers automatic cognitive accessibility of cue–response associations in memory from reaction time. For example, following a cue prime (e.g. park), participants complete a lexical decision task. Strong habits are indicated by shorter response latency to habit words (e.g. running) (e.g. Neal et al., 2011, 2012)
Attentional bias (e.g. Stroop)	An implicit measure that infers automatic habit cue detection from interference (greater response latency) in a Stroop task (e.g. Orbell & Verplanken, 2010)
Action slips and devaluation paradigms	Devaluation paradigms infer habit when an overlearned response to a cue usually acquired in the presence of a reward subsequently persists even when the reward is devalued or is no longer contingent on the behaviour (extinction). The defining feature of habit in animal models. Action slips refer to the responses made following devaluation and refer to observed behaviour in response to a cue that no longer has instrumental value (e.g. Orbell & Verplanken, 2010; Tricomi et al., 2009)
Response frequency measures	Habit may be indicated by the speed with which decisions are being made. Verplanken et al. (1994) developed the Response Frequency measure of habit. Participants are presented with multiple choice scenarios, and are instructed to respond as quickly as possible to each scenario. The prevalence of one particular choice option across the scenarios is taken as a measure of habit. The time pressure is an essential element in this measure
Lever pushing	This method is predominantly used in animal studies on habit, such as reinforcement training in mice (e.g. Rossi & Yin, 2012)
Neuroimaging	Observations that habitually performed behaviours activate brain regions and neural networks associated with the sensorimotor loop, that is distinguished from those neural networks associated with planning and goal-directed behaviour (e.g. Lehéricy et al., 2005)
Measures based on self-reports	**Definition and example**
One item self-reported frequency	Retrospective reports of past performance frequency. These have been widely used in social, health, and consumer psychology research. The may have the format ‘How often did you perform behaviour X in the last month’, accompanied by a scale ranging from ‘never’ to ‘always’
One item self-reported habit	Self-perceptions of habitual performance (Performing behaviour X is something I do by force of habit; e.g. Mittal, 1988)
Frequency in context	Retrospective reports of performance frequency (how often is the behaviour performed) with a measure of context stability (how stable is the performance context). Habit strength is the product of the frequency × context stability terms so that behaviours that are performed often and always in the same cueing context are considered habitual (e.g. Ji & Wood, 2007)

(continued)

Table 22.1 (continued)

Measures based on self-reports	Definition and example
Self-Report Habit Index (SRHI)	Self-perceptions of habit performance comprising 12 items assessing performance repetition, automaticity and self-identification with action (e.g. Performing behaviour X in context Y is something I do….before I realise I am doing it) (e.g. Orbell & Verplanken, 2010, 2015; Verplanken & Orbell, 2003). Gardner, Abraham, Lally, and de Bruijn (2012) dubbed four items of this scale the Self-Report Behavioral Automaticity Index
Habit Index of Negative Thinking (HINT)	Self-perceptions of habitual thinking. This scale is conceptually identical to the Self-Report Habit Index, but six items were reworded to accommodate assessment of mental habits (see: Verplanken, Friborg, Wang, Trafimow, & Woolf, 2007). The scale can be applied as 'stand-alone', similarly to the SRHI. But it can also be used to refer to previously generated thoughts, for instance in a thought-listing task. In that case, the generated thoughts represent the content of thinking, while the HINT represents the habitual quality of thinking
Creature of habit scale	A trait measure of individual differences in habitual responding in everyday life, comprising routines and automaticity in a variety of domains (Ersch, Lim, Ward, Robbins, & Stochl, 2017)

much from the latter as from the former when new contingencies are introduced (Watson & de Wit, 2018).

Defining features of habit, namely cue dependence and repetition history have been neglected in a great deal of correlational research seeking to examine the role of habit in predicting behaviour (Gardner, 2015). Neglect of repetition history in order to avoid method variance with self-reported future behaviour is a weakness that should be rectified by employment of objectively observed behaviour in research design, not by neglect of measurement of repetition. Neglect of cue-context dependency seriously undermines claims of habit, since a good deal of behaviour might be frequent and possess a sense of automatic responding without being a habit. Neglect of *both* cue-context and repetition history substantially undermines claims of habit measurement. Objectively observed behaviour in contexts previously associated with habit, or increased sensitivity to outcome/reward are more relevant measures of intervention success in this case. Ecological momentary assessment may enhance study of habit in context. Relatedly, outcome measures need to evaluate behavioural outcome in context, or employ non-behavioural outcomes of habituation such as weight loss.

We would contend that future research needs to focus on paradigms that illustrate the operation and formation of habit as well as its consequences. In particular, more attention needs to be given to experimental manipulation, observation of *both cue context and response, as well as insensitivity to reward or outcome.* For example, a self-report measure of habit such as the SRHI should show development of habit strength in a context or in response to a cue in which a new habit is acquired, but should not show corresponding development in a different context. Similarly, studies designed to observe diminishing habits or to intervene to diminish habits need to demonstrate that the habit has declined in response to cue-context environments previously associated with habit, or that previously habitual behaviour previously has become outcome dependent. Fundamentally, evidence of habit is provided by observation that habitual actions are performed even when the action has no instrumental value, provided the context cue is present. When these conditions are not met, behaviour might be said to be under motivational control.

Habit, Willpower and Self-Control

Habit, by which means it is possible to act without conscious control, stands in stark contrast with notions of willpower that involve the individual exerting conscious self-regulation of behaviour, by actively pursuing goals or by the employment of self-regulation strategies. Indeed the intersection of intentional and habitual control of action is at the heart of modern social psychological theorising about habit.

Yet emergent evidence raises a paradox- namely- suggestions that self-control might be associated with a greater tendency to create habits (Adriaanse, Kroese, Gillebaart, & De Ridder, 2014; Galla & Duckworth, 2015). The paradox arises because self-control represents a class of executive control processes including response inhibition, that require active and effortful self-management. How can this paradox be resolved? We would contend that the answer may lie in examination of self-report measures of self-control, and in assumptions made about the ways in which self-control guides behaviour.

Self-report measures of self-control require people to respond to items such as ‘I refuse things that are bad for me’, ‘I am good at resisting temptation’, ‘People would say that I have iron self-discipline’ and to reverse coded items such as ‘I am lazy’, ‘I have trouble concentrating’ and ‘I wish I had more self-discipline’. On the face of it these items have validity in assessing self-perceptions of employment of self-regulatory resources to inhibit undesired responding (resisting temptation). Yet Hofmann, Baumeister, Forster, and Vohs (2012) showed in an experience sampling study, that people reporting high state self-control actually *resist fewer* temptations in daily life. Imhoff, Schmidt, and Gerstenberg (2014) report a negative correlation between trait self-control and impulse inhibition in daily routines. One possible interpretation of these findings is that people who are high on trait self-control in fact avoid situations of temptation, so that the effect of self-control on goal achievement and behavioural outcomes rests in the employment of strategies to proactively avoid temptation before it occurs, thereby avoiding the ego depleting consequences of reactive inhibition in daily life. Consistent with this possibility Miles et al. (2016) obtained no evidence that extended *inhibition training* resulted in improved self-control, reduced ego depletion effects or attenuation of the habit-behaviour relation. Their participants did, however, believe that they had improved their self-control during the training. These findings have led researchers to suggest, and to provide correlational evidence that trait self-control is positively correlated with habit. For example, Galla and Duckworth (2015) showed that trait and specific self-control were moderately positively correlated with behavioural habits and that both of these constructs were inversely associated with effortful inhibition and positively associated with a range of behaviours. Examination of self-control items shows that it is entirely plausible that an individual with an established healthy eating habit, or rigid exercise or studying habit might respond affirmatively to items such as ‘People would say that I have iron self-discipline’. The scale assesses the outcome of self-control rather than the process by which it operates and individuals with strong habits who perhaps have little insight into the mechanisms that maintain their habits might also infer that they are good at resisting temptation or distraction (similar to the ways in which people infer intentionality or confabulate reasons for their actions). Resisting temptation or being perceived as high in self-discipline are likely valued self-descriptions. There may be plausible routes by which self-control may be related to behaviour via habit. One route is effortful and self-regulated but operates via avoidance of temptation rather than via exhausting active resistance and focus on temptations. This is consistent with observations that strategic automatization of plans to ignore tempting stimuli are effective in goal achievement (see chap. 10, this volume). However, Galla and Duckworth (2015) showed that both self-control and behavioural habits were inversely associated with attempts to ignore stimuli, so it cannot be concluded that they had acquired habits to ignore distracting stimuli.

Habits are not controlled by effortful resistance or conscious cue avoidance. However, pre-existing habits can protect against situational interference and proximal low self-control (Neal, Wood, & Drolet, 2013). Recently, Lin et al. (2016) reported an experiment in which participants with limited executive control responded to a self-control dilemma (a choice between M&Ms and carrots) by choosing carrots if the previously learned carrot cue (but not a novel cue) was present in the perceptual environment. It would appear that a strong cue-habit response (choosing carrots) can occur under circumstances when it is not possible to avoid perceiving a tempting alternative (M&Ms) and even when self-control is low, provided a cue to desired behaviour has been trained. If behaviour is under cue habituated automatic control, environmental cues (habit architecture) can provide a shield against temptations. For example an individual may have a habit to do homework as soon as returning home from school that effectively inhibits a temptation to watch television. Habit operates independently of motivational state or concurrent effortful control.

Conclusion

This volume highlights two sides of the habit coin. One the one hand, habits are portrayed as rigid structures, which prevent flexible and creative responding, and, if unhealthy or dysfunctional, may lead to sub-optimal or even harmful conditions. Those are the habits we wish to combat and change. On the other hand, we have habits that are useful devices, which make life easier, enhance performance, protect against temptation and create enduring behaviour change. Those are habits we wish to obtain and make part of our self-regulatory toolbox.

To complete William James' (1887) quotation provided at the front of the book: 'Full half the time of such a man [i.e. whose only habit is indecision] goes to the deciding, or regretting, of matters which ought to have been so thoroughly ingrained in him as practically not to exist for his consciousness at all' (p. 447). James' remarkable insights, often delivered in a typically baroque style, have been realised via convergent evidence across disciplines showing that habit is a distinctive as well as an intriguing construct that accounts for a substantial proportion of non-consciously activated behaviour in daily life.

References

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

Abelson, R. P. (1981). Psychological status of the script concept. *American Psychologist, 36*, 715–729.

Adams, C. D. (1982). Variations in the sensitivity of instrumental responding to reinforce devaluation. *The Quarterly Journal of Experimental Psychology Section B, 34*, 77–98.

Adriaanse, M., Gollwitzer, P. M., De Ridder, T. D., de Wit, J. B. F., & Kroese, F. M. (2011). Breaking habits with implementation intentions: A test of underlying processes. *Personality and Social Psychology Bulletin, 37*, 502–513.

Adriaanse, M., Kroese, F. M., Gillebaart, M., & De Ridder, D. T. D. (2014). Effortless inhibition: Habit mediates the relation between self-control and unhealthy snack consumption. *Frontiers in Psychology, 5*, 444.

Adriaanse, M., Kroese, F., Weijers, J., Gollwitzer, P., & Oettingen, G. (2018). Explaining unexplainable food choices. *European Journal of Social Psychology, 48*, O15–O24.

Azrin, N. H., & Nunn, R. G. (1973). Habit-reversal: A method of eliminating nervous habits and tics. *Behaviour Research and Therapy, 11*, 619–628.

Bargh, J. A. (1994). The four horsemen of automaticity: Awareness, intention, efficiency, and control in social cognition. In R. S. Wyer & T. K. Srull (Eds.), *Handbook of social cognition* (Vol. 1, pp. 1–40). Hillsdale, NJ: Lawrence Erlbaum.

Bargh, J. A., & Chartrand, T. L. (2014). The mind in the middle: A practical guide to priming and automaticity research. In H. T. Reis & C. M. Judd (Eds.), *Handbook of research methods in social and personality psychology* (pp. 253–285). New York: Cambridge University Press.

Dijksterhuis, A., & van Knippenberg, A. (2000). Behavioral indecision: Effects of self-focus on automatic behavior. *Social Cognition, 18*, 55–74.

Ersch, K. D., Lim, T.-V., Ward, L. H. E., Robbins, T. W., & Stochl, J. (2017). Creature of habit: A self-report measure of habitual routines and automatic tendencies in everyday life. *Personality and Individual Differences, 116*, 73–85.

Galla, B. M., & Duckworth, A. L. (2015). More than resisting temptation: Beneficial habits mediate the relationship between self-control and positive life outcomes. *Journal of Personality and Social Psychology, 109*, 508–525.

Gardner, B., Abraham, C., Lally, P., & de Bruijn, G.-J. (2012). Towards parsimony in habit measurement: Testing the convergent and predictive validity of an automaticity subscale of the self-report habit index. *International Journal of Behavioral Nutrition and Physical Activity, 9*, 102.

Gardner, B. (2015). A review and analysis of the use of 'habit' in understanding, predicting and influencing health-related behavior. *Health Psychology Review, 9*, 277–295.

George, C. M., Biswas, S., Jung, D., Perin, J., Parvin, T., et al. (2017). Psychosocial factors mediating the effect of the CHoBI7 intervention on handwashing with soap: A randomized controlled trial. *Health Education and Behavior, 44*, 613–625.
Gillan, C. M., Otto, A. R., Phelps, E. A., & Daw, N. D. (2015). Model-based learning protects against forming habits. *Cognitive, Affective & Behavioral Neuroscience, 15*, 523–536.
Gollwitzer, P. M. (1993). Goal achievement: The role of intentions. *European Review of Social Psychology, 4*, 141–185.
Gollwitzer, P. M. (1999). Implementation intentions: Strong effects of simple plans. *American Psychologist, 54*, 493–503.
Graybiel, A. M., & Smith, K. S. (2014). Good habits, bad habits. *Scientific American, 310*, 38–43.
Hofmann, W., Baumeister, R. F., Forster, G., & Vohs, K. D. (2012). Everyday temptations: An experience sampling study of desire, conflict, and self-control. *Journal of Personality and Social Psychology, 102*, 1318–1335.
Imhoff, R., Schmidt, A. F., & Gerstenberg, F. (2014). Exploring the interplay of trait self-control and ego depletion: Empirical evidence for ironic effects. *European Journal of Personality, 28*, 413–424.
Itzchakov, G., Uziel, L., & Wood, W. (2018). When attitudes and habits don't correspond: Self-control depletion increases persuasion but not behavior. *Journal of Experimental Social Psychology, 75*, 1–10.
James, W. (1887). The laws of habit. The Popular *Science Monthly, 31*, 433–451.
Ji, M. F., & Wood, W. (2007). Purchase and consumption habits: Not necessarily what you intend. *Journal of Consumer Psychology (Lawrence Erlbaum Associates), 17*, 261–276.
Lehéricy, S., Benali, H., Van de Moortele, P. F., Pélégrini-Issac, M., Waechter, T., et al. (2005). Distinct basal ganglia territories are engaged in early and advanced motor sequence learning. *PNAS, 102*, 12566–12571.
Lin, P.-Y., Wood, W., & Monterosso, J. (2016). Healthy eating habits protect against temptations. *Appetite, 103*, 432–440.
Marteau, T. M., Hollands, G. J., & Kelly, M. P. (2015). Changing population behaviour and reducing health disparities: Exploring the potential of 'Choice Architecture' Interventions. In R. M. Kaplan, M. L. Spittel, & D. H. David (Eds.), *Population health: Behavioral and social science insights. AHRQ Publication No.15-002* (pp. 105–126). Rockville, MD: Agency for Healthcare Research Quality and Office of Behavioral and Social Sciences Research, National Institutes of Health.
Miles, E., Sheeran, P., Baird, H., Macdonald, I., Webb, T. L., & Harris, P. R. (2016). Does self-control improve with practice? Evidence from a six-week training program. *Journal of Experimental Psychology: General, 145*, 1075–1091.
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.
Neal, D. T., Wood, W., & Drolet, A. (2013). How do people adhere to goals when willpower is low? The profits (and pitfalls) of strong habits. *Journal of Personality and Social Psychology, 104*, 959–975.
Neal, D. T., Wood, W., Labrecque, J. S., & Lally, P. (2012). How do habits guide behaviour? Perceived and actual triggers of habits in daily life. *Journal of Experimental Social Psychology, 48*, 492–498.
Neal, D. T., Wood, W., Wu, M., & Kurlander, D. (2011). The pull of the past: When do habits persist despite conflict with motives? *Personality and Social Psychology Bulletin, 37*(11), 1428–1437.
Orbell, S., & Phillips, S. A. (in press). Automatic processes in illness self-regulation. *Health Psychology Review*. https://www.tandfonline.com/doi/full/10.1080/17437199.2018.1503559
Orbell, S., & Sheeran, P. (1998). 'Inclined abstainers': A problem for predicting health behaviour. *British Journal of Social Psychology, 37*, 151–166.
Orbell, S., & Verplanken, B. (2010). The automatic component of habit in health behavior: Habit as cue-contingent automaticity. *Health Psychology, 29*, 374–383.

Orbell, S., & Verplanken, B. (2015). The strength of habit. *Health Psychology Review, 9*, 311–317.
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.
Phillips, L. A., & Gardner, B. (2016). Habitual exercise instigation (vs. execution) predicts healthy adults' exercise frequency. *Health Psychology, 35*, 69–77.
Rossi, M. A., & Yin, H. H. (2012). Methods for studying habitual behavior in mice. *Current Protocols in Neuroscience, 60*, 8.29.1–8.29.9.
Sheeran, P., Godin, G., Conner, M., & Germain, M. (2017). Paradoxical effects of experience: Past behavior both strengthens and weakens the intention-behavior relationship. *Journal of the Association of Consumer Research*. Published online 17th April 2017. https://doi.org/10.1086/691216.
Skinner, B. F. (1938). *The behavior of organisms*. New York: Appleton.
Tricomi, E., Balleine, B. W., & O'Doherty, J. P. (2009). A specific role for posterior dorsolateral striatum in human habit learning. *European Journal of Neuroscience, 29*, 2225–2232.
Verplanken, B., Aarts, H., van Knippenberg, A., & van Knippenberg, C. (1994). Attitude versus general habit: Antecedents of travel mode choice. *Journal of Applied Social Psychology, 24*, 285–300.
Verplanken, B., & Faes, S. (1999). Good intentions, bad habits, and effects of forming implementation intentions on healthy eating. *European Journal of Social Psychology, 29*, 591–604.
Verplanken, B., Friborg, O., Wang, C. E., Trafimow, D., & Woolf, K. (2007). Mental habits: Metacognitive reflection on negative self-thinking. *Journal of Personality and Social Psychology, 92*(3), 526–541
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., & Roy, D. (2016). Empowering interventions to promote sustainable lifestyles: Testing the habit discontinuity hypothesis in a field experiment. *Journal of Environmental Psychology, 45*, 127–134.
Verplanken, B., Walker, I., Davis, A., & Jurasek, M. (2008). Context change and travel mode choice: Combining the habit discontinuity and self-activation hypotheses. *Journal of Environmental Psychology, 28*, 121–127.
Verplanken, B., & Wood, W. (2006). Interventions to break and create consumer habits. *Journal of Public Policy and Marketing, 25*, 90–103.
Watson, P., & de Wit, S. (2018). Current limits of experimental research into habits and future directions. *Current Opinion in Behavioral Sciences, 20*, 33–39.
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.
Wood, W., & Rünger, D. (2016). Psychology of habit. *Annual Review of Psychology, 67*, 11.1–11.26.
Wood, W., Tam, L., & Witt, M. G. (2005). Changing circumstances, disrupting habits. *Journal of Personality and Social Psychology, 88*(6), 918–933.
Yin, H. H., & Knowlton, B. J. (2006). The role of the basal ganglia in habit formation. *Nature Reviews Neuroscience, 7*, 464–476.

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