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Promoting habit formation

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Habits are automatic behavioural responses to environmental cues, thought to develop through repetition of behaviour in consistent contexts. When habit is strong, deliberate intentions have been shown to have a reduced influence on behaviour. The habit concept may provide a mechanism for establishing new behaviours, and so healthy habit formation is a desired outcome for many interventions. Habits also however represent a potential challenge for changing ingrained unhealthy behaviours, which may be resistant to motivational shifts. This review aims to provide intervention developers with tools to help establish target behaviours as habits, based on theoretical and empirical insights. We discuss evidence-based techniques for forming new healthy habits and breaking existing unhealthy habits. To promote habit formation we focus on strategies to initiate a new behaviour, support context-dependent repetition of this behaviour, and facilitate the development of automaticity. We discuss techniques for disrupting existing unwanted habits, which relate to restructuring the personal environment and enabling alternative responses to situational cues.

Keywords: habit; automaticity; health behaviour; intervention; social cognition

What is a 'habit'?

Many everyday health-related actions are performed repetitively and automatically, with minimal forethought (Ouellette & Wood, 1998). Within psychology, 'habits' are defined as behavioural patterns enacted automatically in response to a situation in which the behaviour has been performed repeatedly and consistently in the past (Verplanken & Aarts, 1999; Wood & Neal, 2009). Recent studies have shown habit strength to increase following repetition of a behaviour in a consistent context (Lally, van Jaarsveld, Potts, & Wardle, 2010; Lally, Wardle, & Gardner, 2011). When a new action is performed, a mental association between situation and action is created, and repetition reinforces and establishes this association in memory (Wood & Neal, 2009), making alternative actions less accessible in that situation (e.g., Danner, Aarts, & de Vries, 2007, 2008). Subsequently, when the associated context cue is encountered, the habitual response is automatically activated. While enactment of behaviours regulated by motivation typically requires deliberate effort, habits are thought to be triggered automatically and so may occur in the absence of awareness, conscious control, mental effort and deliberation (Bargh, 1994). Actors forming

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habits tend to find that, with repetition, the cognitive effort required to act decreases, and initiation becomes 'second nature' (Lally et al., 2011).

As a consequence of automatic initiation, habit is hypothesised to have two interrelated effects on behaviour: firstly, at least where associated with commonly encountered cues, habit prompts frequent performance; and secondly, in the presence of these cues, habits may dominate over intentions in regulating action (Hall & Fong, 2007; Triandis, 1977). These predictions have been empirically supported for health-related behaviour. A recent meta-analysis of healthy eating and physical activity habits showed a medium-to-strong weighted habit–behaviour correlation (random-effects $r_+ = 0.46$), and found that eight of nine investigations of the moderating effect of habit showed intentions to have a lesser impact on action as habit strength increased (Gardner, de Bruijn, & Lally, in press). Other reviews have found that behaviours which are performed frequently in consistent settings (and so are likely to have become habitual; Lally et al., 2010) tend to persist even where motivation shifts (Ouellette & Wood, 1998; Webb & Sheeran, 2006). Habits may therefore be difficult to inhibit even when they conflict with conscious intentions (Hofmann, Friese, & Wiers, 2008; Verplanken & Faes, 1999).

Progress in understanding the relevance of habit to health has until recently been constrained by measurement problems. Traditionally it was assumed that, because habits develop through repetition, measures of past behavioural frequency provided an adequate proxy for habit (Triandis, 1977). However, in stable decisional contexts, repeated deliberation and habit can both prompt frequent action (Gardner, 2009), and so frequency does not distinguish between reasoned and habitual action (Ajzen, 2002; Verplanken, 2006). A measure that combines performance frequency ('how often do you do behaviour X?') and context stability ('when you do behaviour X, how often is cue Y present?') has been proposed (Ouellette & Wood, 1998), applications of which have produced patterns which conform to theoretical predictions (e.g., Wood, Quinn, & Kashy, 2002; Wood, Tam, & Witt, 2005). The validity of this measure is however limited because it assesses only the likelihood that habit has developed, but not the strength of the automatic response that characterises habit (Gardner et al., in press). More recently, a Self-Report Habit Index (SRHI; Verplanken & Orbell, 2003) has been proposed. The SRHI consists of 12 items which assess features of habitual action: repetition, automaticity (uncontrollability, lack of awareness and cognitive efficiency), and relevance to self-identity. The SRHI has been found to adhere to theoretical predictions by correlating strongly with behaviour and moderating the intention–behaviour relationship in stable decisional contexts (Gardner et al., in press). The SRHI is the most commonly used habit measure and can be used to track habit formation (Gardner et al., in press; Lally et al., 2010).

Habits and health behaviour change

Many health goals are served only by repeated action. For example, losing (or maintaining) weight can be achieved by consistently eating a healthy diet and/or taking frequent physical activity to ensure a negative (or neutral) energy balance. Where used to promote achievement of such goals, 'behaviour change' refers to a long-term process characterised by initiation of a new health-promoting behaviour, and maintenance (i.e., repetition) of this behaviour over time. The habit concept

yields potential applications for this process. Often, the effectiveness of behaviour change interventions is constrained because, when an active intervention period ends, so too does engagement with the target behaviour, and short-term behavioural gains are lost in the long-term (Jeffery et al., 2000). The formation of healthy habits may make healthy behaviours more resistant to unhealthy lapses, and so aid maintenance beyond the intervention period (Lally, Chipperfield, & Wardle, 2008; Rothman, Sheeran, & Wood, 2009).

Many health behaviours that are targeted in interventions can potentially become habitual: applications of the SRHI within observational studies have suggested that eating behaviours, physical activity, active travel and hand hygiene often have a habitual component (Aunger et al., 2010; de Bruijn, 2010; de Bruijn & Gardner, 2011; Gardner et al., in press; Rhodes, de Bruijn, & Matheson, 2010). There is therefore potential to apply a habit formation approach in designing health behaviour change interventions. However, as far as we are aware, only one health promotion intervention based explicitly on a habit formation model has been designed and evaluated to date (Lally et al., 2008; Lally et al., 2011). The 'Ten Top Tips for Weight Loss' was a leaflet-based intervention that recommended a set of behaviours to be performed daily and advocated doing the behaviours in a similar way and in a similar context every day. A simple self-monitoring sheet was included. In an exploratory trial, an average weight loss of 2 kg at 8 weeks was observed among intervention participants, compared with 0.4 kg in a waiting list control group (Lally et al., 2008). Completers in the intervention group lost 3.8 kg over the 32 week trial. Qualitative analysis of interviews with a small sample of intervention recipients indicated that participants experienced gains in automaticity (Lally et al., 2011). These studies point to both the feasibility and potential effectiveness of using habit-formation principles in health behaviour change interventions.

Defining habit as an automatic cue-response acquired through context-dependent repetition (Lally et al., 2010) generates theoretical propositions regarding purposive formation of health-promoting habits, and these propositions have received empirical support. The principle underlying habit formation is that, if a specific behaviour is performed repeatedly in an unvarying context, a habit will develop (Lally et al., 2010; Triandis, 1977; Wood & Neal, 2007). Habit formation thus requires progression through four stages. Firstly, a decision must be made to take action. Numerous theories focus on psychological predictors of intention formation (e.g., Ajzen, 1991; Bandura, 1997; Schwarzer, 1992), and empirical evidence demonstrates that changing these predictors will likely change intentions (e.g., Fife-Schaw, Sheeran, & Norman, 2007; Webb & Sheeran, 2006) though there has been less focus on persistence of changes in the longer-term. Secondly, the decision to act must be translated into action. The 'intention–behaviour gap' is well-documented (e.g., Webb & Sheeran, 2006), and may be overcome by using self-regulatory strategies such as planning (Michie, Abraham, Whittington, McAteer, & Gupta, 2009). Thirdly, the behaviour must be repeated, which usually requires continued motivation (Rothman, 2000), and may also be supported by self-regulatory techniques (Michie et al., 2009). These three stages are generic principles of 'behaviour change' (as defined above), and indeed habit formation depends upon initiation and repetition of a novel behaviour (Lally et al., 2010; Lally et al., 2011). A fourth stage, which is closely related to the third, pertains exclusively to habit formation: the new action must be repeated *in a fashion conducive to the development*

of automaticity. Recent studies showed that participants encouraged to perform a health-promoting behaviour (e.g., eating fruit, drinking water, taking physical activity) regularly in consistent contexts reported increases in habit-related automaticity (Lally et al., 2010; Lally et al., 2011). The transition of intention into action can be obstructed where health-compromising habits exist. Breaking such habits will require disrupting the cue-response association, and recent research shows that discontinuing exposure to habit cues (Verplanken, Walker, David, & Jurasek, 2008; Wood et al., 2005), or programming alternative responses to these cues (Adriaanse et al., 2010; Quinn, Pascoe, Wood, & Neal, 2010), can help to translate motivation into action conducive to good health.

Research relating directly to the formation of health-enhancing habits in everyday life is scarce. There are however a number of relevant literatures that can be drawn on to provide insights into the mechanisms operating during the process, and the factors likely to influence habit disruption and acquisition. The concept of behaviour as an automated and reflexive cue-response directed by learned associations is rooted in classical behaviourism, and studies of animal learning of stimulus-response contingencies (e.g., Hull, 1943; Skinner, 1938; Thorndike, 1911; Tolman, 1932). More recent work has sought to reconcile behaviourist principles of associative learning with cognitivist portrayals of human action as goal-directed and cognitively mediated (e.g., Bargh, 1994). This has given rise to models of habit as cue-responses formed via repeated performance of actions which are initially typically deliberative, but become regulated by an impulsive cognitive system (Strack & Deutsch, 2004; Wood & Neal, 2007). Hence, in this review, we draw on insights from cognitive, motivational and behaviourist literatures to offer evidence-based suggestions for health promotion strategy. While we acknowledge that further empirical research into habit formation and disruption is required, the primary purpose of this review is to generate recommendations around how interventions might support habit formation, based on available theory and evidence.

Our review is organised in accordance with the discrete stages involved in creating healthy habits (and breaking unhealthy habits) described above (discussion of intention formation is beyond the scope of this review, but the intention-change literature has been synthesised elsewhere [see e.g., Webb & Sheeran, 2006]). Habit development requires initiation and maintenance of a new behaviour, and so evidence pertaining to the translation of intention into action (including breaking habits), and the promotion of repetition, applies not only to habit formation, but also to behaviour change more generally. A section describing how best to support the development of automaticity pertains exclusively to habit formation.

Forming habits

Although conceptual discussion in the field often implies a distinction between 'habits' (automatic responses to specific cues) and 'non-habits' (non-automatic responses), automaticity is more realistically conceived of as a continuum (Moors & de Houwer, 2006). In the only study to date to have tracked the formation of healthy habits in a naturalistic setting, repeating a behaviour in the presence of consistent cues was shown to result in the behaviour becoming more automatic (Lally et al., 2010). Within this study, 96 participants performed a self-selected health-promoting action once-daily, in response to a stable cue (e.g., 'going for a walk after breakfast').

Habit formation, tracked using an automaticity-specific subscale of the SRHI, was found to typically follow an asymptotic curve (see Figure 1): initial repetitions caused large increases in automaticity, but with each new repetition, automaticity gains reduced until the behaviour reached its limit of automaticity (for similar findings from the animal learning literature, see e.g., Adams, 1982 and Dickinson, 1985). These findings suggest that interventions should aim to promote sufficient context-dependent repetition of the behaviour for the asymptote to be reached, and with as few repetitions as possible. Some self-help programmes have claimed that it takes 21 days to form a habit (e.g., Maltz, 1969) but it is generally agreed among researchers that habit formation is a slower process than this (Redish, Jensen, & Johnson, 2008; Rothman et al., 2009). Lally et al. (2010) found the average time for participants to reach the asymptote of automaticity was 66 days, with a range of 18–254 days (possible explanations for this variability are discussed below).

Translating intention into behaviour: Planning

Intentions to act are significant precursors of initiation of behaviour, but 'intention-translation' is imperfect (Sheeran, 2002; Webb & Sheeran, 2006). A review of studies across a number of health-related behaviours showed that among those who intended to perform these behaviours, the average rates of performance were only 47% (Sheeran, 2002). This 'intention–behaviour gap' may be partly attributed to features of the motivation to perform the behaviour. For example, the salience, priority, strength and stability of intentions all influence whether a person who forms an intention to take a certain action remains disposed to do so at a later time when a performance opportunity arises (Bagozzi & Yi, 1989; Sheeran, Orbell, & Trafimow, 1999). In this paper we focus on a second class of reasons that can explain why people fail to act on their intentions. These 'volitional' (or 'post-intentional') factors are conceptually independent of motivation and relate to the ability to put plans into action (Schwarzer, 1992).

Remembering to perform a previously planned (intended) action has been termed a prospective memory task, and such tasks are ubiquitous in daily life (Einstein &

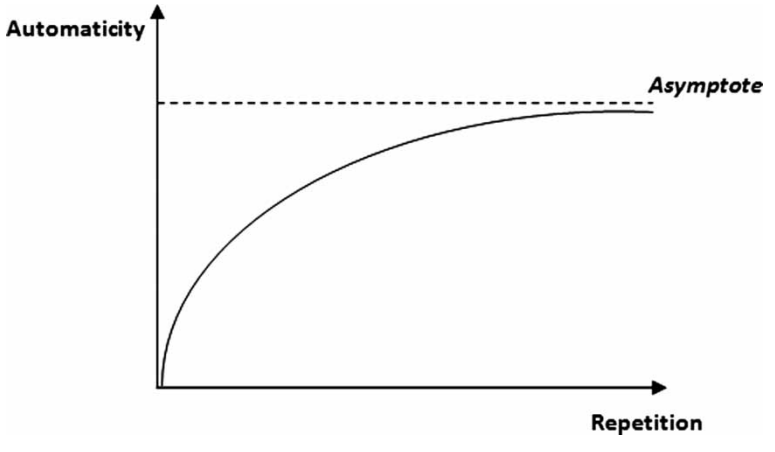

Figure 1. Habit formation following an asymptotic curve.

McDaniel, 2005). People can fail to act on their intentions when the opportunity to act presents itself because they forget to enact their intended action. One important approach to help people remember their intentions is the formation of a plan. Two prominent theories have highlighted the importance of planning in intention translation: the Health Action Process Approach (Schwarzer, 1992) and Control Theory (Carver & Scheier, 1982). Both suggest that planning increases the chances that the intended behaviour will be performed, a hypothesis well-supported by empirical evidence (Sniehotta, Schwarzer, Scholz, & Schüz, 2005). 'Action plans' specify the behaviour that should be performed in a given situation (Schwarzer, 1992), and are often spontaneously used in the 'real-world' to successfully translate intentions into behaviour (Sniehotta, 2009; Sniehotta et al., 2005). 'Implementation intentions' are a sub-type of action plans which require detailed specification of features of the situation and the intended response to this situation (Gollwitzer, 1999). They link foreseeable situational cues with goal-directed responses, and are of the form 'if situation Y is encountered then I will initiate behaviour Z (in order to reach goal X)' (Gollwitzer, 1999). Unlike real-world action plans, implementation intentions are rigidly structured if-then rules that tie behaviour to a specific anticipated context, and so tend to be provided by researchers as part of a purposive intervention or experimental procedure, rather than self-generated (Sniehotta, 2009).

A recent meta-analysis showed that implementation intentions had a medium to large effect on promoting initiation of an intended behaviour (Gollwitzer & Sheeran, 2006). Implementation intentions have also been shown to increase the rate of performance of the planned behaviour (in the case of teeth-flossing) and the level of habit strength over time (Orbell & Verplanken, 2010). Implementation intentions are thought to operate by heightening the accessibility of the chosen situational cue in memory, and forging a cue-response association that is activated when the cue is encountered. In theory, the behaviour then proceeds automatically in a similar way to a habit (Webb & Sheeran, 2007) although, in contrast to habits, implementation intentions are only effective when the superordinate goal towards which the plan was aimed continues to be endorsed (Orbell & Verplanken, 2010; Sheeran, Webb, & Gollwitzer, 2005; Wood & Neal, 2007).

Prospective memory research can provide insights into how to form implementation intentions for maximum effect. Firstly, enactment of a plan is most likely if the cue to action is an event, rather than a time-based cue, because a time cue requires ongoing monitoring in order to identify the appropriate opportunity to act, whereas an event-based cue does not (McDaniel & Einstein, 2000). The event-based cue allows for the automatic retrieval of habit associations due to the heightened cue accessibility achieved by formulating implementation intentions. Cues that are more distinctive in appearance or more novel are more salient, and therefore more effective in eliciting planned behaviour (McDaniel & Einstein, 1993). In addition, when ongoing tasks (i.e., activities which people already do in their daily life) focus attention on aspects of the context that are relevant for performance of the intended action (the chosen cue), people are more likely to enact their plan (Marsh, Hicks, & Hancock, 2000; Meier & Graf, 2000). Indeed, office workers enrolled on Lally and colleagues' 'Ten Top Tips' weight loss intervention typically performed new health behaviours at salient points in their work routines (e.g., arrival at work or lunchtimes; Lally et al., 2011). The most effective cues for implementation intentions may therefore be distinct events in daily life which are unlikely to be missed.

Plans can relate not only to performance of the behaviour, but also to overcoming potential obstacles to performance. 'Coping planning' involves anticipating difficulties that might hinder action, and forming concrete plans to deal with these situations (Sniehotta et al., 2005), such as, when dieting, planning how to cope with a social situation in which high-calorie foods will be offered. Coping planning has been shown to improve performance of various health behaviours (Sniehotta, Scholz, & Schwarzer, 2006; van Osch, Lechner, Reubsaet, Wigger, & de Vries, 2008). van Osch et al. (2008) also demonstrated the utility of coping plans for reducing an unwanted behaviour. Participants who formed coping plans to refrain from smoking increased their 7-month abstinence rates to 13.4% compared with 10.5% in the control group. Both action-planning and coping-planning have been shown to promote behaviour change when used independently or in combination (Sniehotta et al., 2005, 2006).

Implementation intentions can also be effective in shielding goal pursuit from the influence of conflicting thoughts or feelings. Achtziger, Gollwitzer, and Sheeran (2008) showed that participants motivated to halve consumption of a self-chosen high-fat snack were better able to do so where they had formed implementation intentions for coping with cravings ('if I think about my chosen food, then I will ignore that thought'; p. 384). Implementation intentions can thus be used to implement either a given action or the inhibition of unwanted actions.

The effectiveness of plans may depend on their cognitive accessibility during opportunities for action. In some situations, people can be helped to remember their plans by providing them with reminders. Text messaging provides a possible medium for reminders of either implementation intentions or the goals underlying these. Text messages have been found to increase rates of physical activity in comparison with control groups who received no reminders (Prestwich, Perugini, & Hurling, 2009, 2010; Webb, Joseph, Yardley, & Michie, 2010).

Effective planning may require accurate appraisals of current behaviour, in order to recognise discrepancies between current and desired performance (Carver & Scheier, 1982). In this respect, self-monitoring can be especially useful. Self-monitoring involves keeping a record of specific behaviours (or outcomes of behaviour), and has long been a central component in behavioural weight loss programmes (Cooper, Fairburn, & Hawker, 2003). Self-monitoring can help to identify persistent unwanted behaviours, and so is potentially conducive to the mobilisation and implementation of strategies to reduce discrepancies between current and desired behaviour. It can also help identify opportunities to perform a new behaviour, for which implementation intentions can be made. For example, people can identify situations in their day when they could add in physical activity and identify a cue for this future action. A recent meta-analysis of interventions to change physical activity and eating behaviours showed that interventions that included self-monitoring were significantly more effective than interventions without monitoring (Michie et al., 2009).

Promoting continued repetition

To form a habit, a behaviour must be carried out repeatedly in the presence of the same contextual cues (Lally et al., 2010). Consideration must therefore be given to post-initiation variables that may sustain or discourage continuation of behaviour (Borland, 2010).

Whether a behaviour that has been performed a small number of times goes on to be repeated will largely depend on people continuing to want to perform the new action following its initiation. This is likely to depend on responses to the consequences of action. At the early stages of a long-term behaviour change attempt, goal-directed actions which prompt negative affect are typically discontinued, whereas those which give rise to positive emotions can bolster commitment to change and increase effort (Louro, Pieters, & Zeelenberg, 2007). A diary study of female students engaged in weight loss attempts showed that, of participants who self-reported being furthest from achieving their long-term goals, those who experienced positive emotions arising from weight-loss behaviour on one day expended greater goal-directed effort on the subsequent day than did those who experienced negative emotions (Louro et al., 2007, Study 1).

Satisfaction is likely to be important in maintaining novel actions: actors dissatisfied by the experience of a new behaviour typically disengage from the behaviour change attempt. Satisfaction is thought to be significant because 'the feeling of satisfaction indicates that the initial decision to change the behaviour was correct' (Rothman, 2000, p. 66). Baldwin et al. (2006) found that self-efficacy (belief in one's capabilities) predicted future quit attempts in smokers who had not yet made an attempt, but satisfaction with the experience of cessation predicted longer term success among those who had already quit.

Satisfaction arises from attaining valued anticipated outcomes of performance (Rothman, 2000). One concern has been that unrealistic prior expectations about the consequences of a behavioural change (e.g., how slim one would look after losing 5 lb) may have the unintended effect of decreasing satisfaction and thereby reducing motivation to persist (Rothman, 2000). Although the evidence in support of this hypothesis is currently inconclusive (e.g., Finch et al., 2005; Hertel et al., 2008; Szymanski & Henard, 2001), it seems prudent to consider this when designing interventions.

There are various outcomes with which actors may be (dis)satisfied (Rothman, 2000). A potentially key outcome is whether the person perceives the behaviour to have progressed them towards their goal. For many health behaviours, progress can be difficult to identify, particularly in the short-term. For example, choosing low saturated-fat foods can contribute to the goal of reducing cholesterol, but it is difficult to assess the contribution made by each low-fat food choice. Ensuring realistic expectations and managing evaluation of outcomes once the behaviour has been initiated could be helpful.

Rothman et al. (2009) argue that people focus on different outcomes of their behaviour depending on their goals, and that those who are high in self-esteem and optimism may be able to switch their focus to different domains of success when needed. Highlighting accrued successes and achievements in a number of areas that are contingent upon changes in behaviour may help people to change their focus if needed and therefore increase satisfaction.

Satisfaction may also be boosted by directing people's attention towards likely outcomes of which they may not be aware or may otherwise undervalue. For example, the mere performance of a personally valued action might itself be portrayed as a worthwhile goal. Additionally, as behaviours are repeated and automaticity develops, initiation becomes less effortful, and so satisfaction may be

enhanced by emphasising progressive ease of performance as a probable and observable intervention outcome (Lally et al., 2011).

The type of motivation underpinning initiation of behaviour may also influence continuation. Health-promoting actions which are extrinsically motivated – i.e., performed to attain tangible rewards or avoid punishments, comply with instructions, or otherwise satisfy external demands – may be less likely to be repeated than actions pursued due to genuine personal interest (i.e., intrinsic motivation), at least when external support for action is removed (Ryan & Deci, 2000). Intervention developers must therefore promote behaviours in a way that encourages people to internalise the need and desire for change, thus engendering self-determined, rather than compliant, behaviour change (Deci & Ryan, 1985).

Self-Determination Theory suggests strategies for promoting the internalisation of externally regulated motives, and these operate by satisfying needs for connection with others, competence and autonomy (Ryan & Deci, 2000). Change attempts supported by people to whom the actor can relate, or that promote both competence and autonomy, are likely to boost intrinsic motivation and so facilitate repeated action (Deci & Ryan, 2000; Ryan & Deci, 2000). The 'lay tutor' model, whereby behaviour modification is supported by non-professionals with personal experiences relevant to the change attempt (e.g., Abraham & Gardner, 2009; Wilkinson, Sniehotta, & Michie, in press), may be effective in this regard. Competence and autonomy needs are hypothesised to interact, such that, even if people are competent in performing an action, it is unlikely to become internalised if seen to be regulated by external forces (Ryan & Deci, 2000). People engaged in behaviour change attempts should ideally be supported in making self-directed changes, rather than following external instructions and so performing actions in which they may otherwise be disinterested. Positive feedback for performing new behaviours can encourage people to continue with the new behaviour (Baldwin, Rothman, & Jeffery, 2009), by promoting autonomy and competence and so boosting intrinsic interest (Deci, 1975). Conversely, providing salient and tangible rewards for behaviour may undermine intrinsic motivation, because actors perceive such behaviours to be directed by external demands (Ryan & Deci, 2000).

Many of the self-regulatory processes relevant to initiation of behaviour are also likely to be important in ensuring repetition in the habit acquisition phase (Heckhausen & Gollwitzer, 1987). Planning is as important for helping people repeat a behaviour as it is for initiation. Coping planning may be particularly important for supporting continued repetition of behaviour. One study found that for physical activity, higher levels of coping planning led to a stronger intention–behaviour association, although only for those who were physically active at the start of the study (Scholz, Schüz, Ziegelmann, Lippke, & Schwarzer, 2008). Therefore in interventions aimed at long-term change, coping planning may be particularly important once a new behaviour has been adopted.

Once a novel behaviour has been initiated, self-monitoring draws attention to this behaviour and so can make it easier to recognise compliance with behavioural goals. In addition, self-monitoring of the outcomes of behaviour (such as weight) offers a means to help people observe how behaviour facilitates progression towards their overall goal (Burke, Swigart, Turk, Derro, & Ewing, 2009). In addition, monitoring the context can allow people to ensure that they are performing the behaviour in the

same way on each occasion and thereby encourage contextual stability, which in turn will enable habit formation.

A recent review has shown that the benefit of self-monitoring is enhanced by the provision of feedback on performance (Michie et al., 2009). Self-recording performance can provide a form of internal feedback, and by having others comment on observed performance, can also facilitate external feedback. Both forms of feedback facilitate positive reinforcement, which can help people stay (intrinsically) motivated during the acquisition phase. Reviewing behavioural goals can also be effective (Abraham & Michie, 2008). This involves reconsideration of goals set previously and can help to ensure targets remain realistic (to avoid later dissatisfaction), while also being rewarding when goals are achieved.

Supporting the development of automaticity

Although context-dependent repetition is necessary for habit formation, it is unlikely to be sufficient, because there are situations in which frequent behavioural performance in an unchanging setting does not lead to habit formation. For example, doctors may prescribe the same medication frequently to their patients but this should not be a habit (cf. Verplanken, 2006). In this section we discuss factors that may determine whether and how quickly a habit forms, and offer recommendations for how to promote the development of automatic responses to contextual cues.

Rewards

The role of reward as a reinforcer of cue-response associations has been extensively studied within the behaviourist literature. Early work showed that, where performance is highly rewarding, the likelihood that behaviour would be repeated was high (Skinner, 1938; Thorndike, 1911), and, traditionally, habits were thought to develop only when rewards were received for each repetition of behaviour (Hull, 1943, 1951). Distinctions between types of reward are needed here (Deci, Koestner, & Ryan, 1999). A fundamental distinction can be drawn between extrinsic (tangible) rewards (e.g., financial incentives), and intrinsic rewards (e.g., pleasure, satisfaction). Extrinsic rewards can be further discerned according to whether they are anticipated prior to performance, and if so, whether the reward is conditional upon mere engagement in the behaviour, achieving a level of behavioural performance, or attaining an outcome subsequent to performance (Deci et al., 1999).

Providing external rewards for each performance of a behaviour has the potential to hinder the habit-formation process. Frequent external rewarding of behaviour can, via instrumental learning of behaviour–outcome associations (Tolman, 1932), lead future performance to be driven by the expectation that behaviour will lead to the reward (e.g., Colwill & Rescorla, 1985). Extrinsic rewards can thereby reduce intrinsic motivation to continue to perform the behaviour (Deci et al., 1999). Reinforcing behaviour using anticipated and conditional tangible rewards may not be problematic for the development of automaticity per se if the reward is consistently available following performance and retains its rewarding value over time (Dickinson, 1985), but in practice it may be unfeasible and costly to reward behaviour indefinitely. Moreover, habit (as a cue-response) is characterised by persistent performance when a tangible reward is removed or devalued (Dickinson,

1985). Automatic action explicitly directed towards the goal of achieving an outcome experienced as contingent on behaviour would not therefore constitute a habit. The distinction between goal-directed automaticity and habit is important: goal-directed automatic behaviour would likely be discontinued following removal or devaluation of the reward, but habitual action would not (Wood & Neal, 2009).

Extrinsic rewards are likely to facilitate habit formation only where attainment of the reward does not become the goal of performance (Dickinson, 1985). Effective habit formation may require that any extrinsic rewards do not appear contingent on performance, or are otherwise unanticipated, such that people are not focused on or motivated by reward when they think about the behaviour. It has been proposed that, if extrinsic rewards are to be used for habit formation purposes, the individual should have limited awareness that changes in behaviour result in changes in an external reward (Ferster & Skinner, 1957; Wood & Neal, 2009). Perceived contingency between behaviour and reward is higher when rewards are proportional to the behaviour performed and lower when rewards appear random in size and timing (Wood & Neal, 2009). Where feasible, tangible and randomly-scheduled rewards for health-promoting action might be delivered to individuals progressing towards long-term behaviour change goals.

More work is needed to understand the relationship between habit formation and external rewards, and the ideal contingencies for promotion of repetition of behaviour so as to strengthen the cue-response link underlying habitual action. Notably, in Lally et al.'s (2010) study of real-world development of healthy dietary or activity habits, no external reinforcement was provided, yet habits formed. This could be because participants chose a behaviour which they were intrinsically motivated to adopt, and so performance was implicitly rewarding. Extrinsic rewards may not therefore be necessary for habits to form. Intervention developers may prefer lower-cost behaviour change programmes that do not involve reward provision. Where rewards are not employed, it is important to ensure that habit formation attempts focus on supporting intrinsically motivated behaviour change.

Consistency

James (1890) hypothesised that uninterrupted performance of behaviour was a necessary condition for habit formation, and a single missed opportunity would reverse all previous learning. This hypothesis has recently been addressed in real-world health contexts. Lally et al. (2010) found that one missed opportunity had a negligible impact on habit formation. A study of the development of exercise habits over a 12-week period found that lapses (defined as missing a week of attendance) in performing the behaviour predicted poorer future performance, particularly within the first 5 weeks of the study (Armitage, 2005). Habit formation may therefore be best aided by consistent repetition of behaviour when the cue is encountered, but it is not necessary to imply that participants should give up if an occasional omission is made. In the 'Ten Top Tips' weight loss intervention discussed above (Lally et al., 2008), a self-monitoring sheet provided space for participants to indicate whether each behaviour had been performed for at least five days out of seven, which conveyed a message of consistent but not necessarily rigid repetition. A potential problem with this approach is that, if guidance is too permissive, the frequency of repetitions may fall below the level of consistency required for habits to form.

Performing multiple behaviours in response to the same cue can reduce the chances that any one response will become habitual, because the mental cue-response association can be diluted by associations between the cue and alternative responses (Wood & Neal, 2007). This idea is echoed by models of goal systems (Kruglanski et al., 2002) which argue that if many behaviours can be used to achieve a goal, the association between the goal and any one behaviour is reduced. It may therefore be important to choose a cue that is not already associated with many other responses.

Behavioural complexity

It has been argued that behaviours which require high levels of flexibility in performance remain controlled by a deliberative planning system rather than becoming habitual (Redish et al., 2008). However Wood et al. (2002) showed in a diary study that even complex behaviours, when repeated in stable circumstances, resulted in less behaviour-relevant thought than when they had not been practised. This suggests that complex behaviours can become somewhat automatic but less so than simple behaviours. For behaviours that require flexibility (e.g., going for a run in a town), it may be helpful to focus on making the initiation of a behavioural pattern habitual. Initiation of an action sequence may invest people in and commit them to completing the sequence; for example people who have initiated 'going for a run' by putting on their running shoes and leaving the house are more likely to continue with their run than those who have not initiated the behaviour (Verplanken & Melkevik, 2008).

Cues

In theory, any salient features of the context in which a behaviour is consistently repeated can come to cue habits (Verplanken, 2005; Wood & Neal, 2009). Some cues may however be better suited to supporting habits than others. The ease of identifying the appropriate cue to action will influence habit formation. Verplanken (2006) conducted an experiment using a word processing task where participants were asked to underline each occurrence of the word 'she' or references to 'a mammal or an object that can be moved' in a body of text. Participants in both groups underlined the same number of words. Those for whom it was more difficult to identify when to act (mammals or movable objects) subsequently reported that completing the task was less automatic than did those for whom it was easy.

Preceding actions can operate as cues for habits, for example flossing after brushing your teeth (Verplanken, 2005). It seems likely however that in the flow of everyday routines, there may be certain points at which it is easier to insert a new behaviour. Behaviours are often linked together in 'chunked' sequences, so that the performance of one behaviour cues the next (Graybiel, 1998). In addition, behaviours are organised in a hierarchical structure with simple actions grouped into sequences, which are part of larger tasks (Botvinick, Niv, & Barto, 2009). For example the actions 'grasp a spoon', 'use spoon to scoop sugar', 'move spoon over cup' and 'deposit sugar in cup' are grouped into the superordinate sequence 'add sugar', which is part of the overarching task of 'make tea' (cf. Cooper & Shallice, 2000). As behaviours are practised, initiation of an action sequence can become automated but this automation may not happen equally for all parts of a sequence. Lower level

actions within a task (e.g., 'grasp spoon') are automated quicker than are higher level actions ('add sugar') at the beginning of a task ('make tea'; Ruh, Cooper, & Mareschal, 2010). It is at the interface between the end of one higher-level action and the initiation of another (i.e., a 'large' 'task boundary'), such as the beginning or end of the task of making tea, that people make the most action slips and do something opposed to their intentions (Botvinick & Bylsma, 2005), presumably because the link to the next action is less strong. The best point to insert a new habit would therefore be at a large task boundary when a task is complete; because there are many different actions that someone might go on to perform at this point, there will likely be less competition from an established habit. In addition, task completion should be a salient cue because it is part of an ongoing action (McDaniel & Einstein, 1993). The more salient the cue, the higher the chance that the new planned behaviour will be performed, and so habit formation should be more likely.

Breaking unwanted habits

Creating new healthy habits often requires substituting an existing undesired action for a more desirable alternative (cf. Bouton, 2000). However, for behaviours that are performed frequently in consistent contexts (and so likely to be habitual), intention change is a weak predictor of changes in behaviour (Webb & Sheeran, 2006). That intention change remains predictive in such instances suggests that intention formation alone has the potential to overcome unwanted habits (Danner, Aarts, Papies, & de Vries, 2011). Often in these instances however, when an opportunity to act presents itself, many individuals behave as they have done previously, in line with their habits, despite being motivated to perform an alternative (Wood, Tam, & Witt, 2005). When designing interventions it is important to consider the challenge of previously established unwanted habits.

An appealing solution to breaking a habit is to remove the person from any environment which cues unwanted habitual responses (Wood et al. 2005; Verplanken et al. 2008). Discontinuing exposure to habit cues disrupts habitual action and also allows for a new habit to be attached to cues in the new environment (Verplanken et al., 2008). In some situations purposive context change may be a feasible intervention strategy, for example people can be encouraged to walk a different route to work avoiding a shop where they usually buy unhealthy foods. This may be the most straightforward approach for breaking habits and so should be employed where it is possible to capitalise on naturally occurring context changes, such as for example moving house. These instances offer a 'window of opportunity' in which old habits can be broken and people may be more receptive to intervention efforts aimed at forming new healthy habits (Verplanken & Wood, 2006). However, alternative approaches are also needed to help break unwanted habits without major modification of the environment in which people live.

Reminders in the environment are a useful tool for helping people to remember their planned future behaviours (Einstein & McDaniel, 1990) and if placed appropriately, may also be useful in interrupting habit performance. If habit is cued by a location, placing an environmental reminder not to perform the behaviour in this location may help to disrupt the habit. For example, point-of-decision prompts at lifts or escalators have been shown to increase stair use (Soler et al., 2010). In an intervention to promote recycling of paper among office workers,

Holland et al. (2006) altered the environment by placing attractive recycling boxes next to waste paper baskets and found that this had a significant impact on recycling behaviour. Habit strength was not assessed in this study. However, it can be assumed that, given the repetitive patterns of paper disposal in an unchanging office environment, office paper disposal behaviours may become habitual. Hence, given the high frequency of 'trashing' paper at pre-intervention baseline, use of non-recycling bins to 'trash' paper was likely an (undesirable) habit prior to intervention. Were the recycling behaviour to have continued, paper recycling would likely have become habitual. Another study looked at the influence of environmental reminders in more detail (Tobias, 2009). Results showed that, while reminders gradually lost their effect over time, behaviour continued to be performed, presumably because habits had formed (Tobias, 2009). The diminishing effect of reminders poses a potential problem for habit formation in that a reminder may lose its impact on behaviour before habits are formed. This may perhaps be solved, however, by replacing initial reminders with salient alternative reminders.

It is unhelpful to think in terms of a habit for *not* doing something (Sheeran, 2002; Sutton, 1994). Automatic elicitation of an unwanted habitual response will likely require that the associated cue is linked with a new alternative response, rather than a non-response (Bouton, 2000). The new cue-behaviour association may then be repeated sufficiently to make it stronger than the association between the cue and the old response. Vigilant monitoring, which involves thinking 'don't do it' and paying attention to potential slip-ups, can offer an effective way of inhibiting habits because it enables the individual to identify cues and exert control in order to inhibit the unwanted habitual response (Quinn et al., 2010). However, this requires a high level of self-control, and when self-regulatory resources are depleted people are less able to control their habits (Hagger, Wood, Stiff, & Chatzisarantis, 2009; Neal, Wood, & Quinn, 2006). If people are highly motivated and have a high level of self-regulatory resources, vigilant monitoring may enable them to exert self-control at each opportunity for long enough to form a new habit association that is stronger than the old habit. However as discussed above, this is likely to require a large number of repetitions and so may be challenging.

Exertion of self-control over existing habits may be aided by promoting awareness of the cues which trigger these unwanted responses. An important way for people to understand their habits is to self-monitor their behaviour over time so as to reveal the situations in which they perform unwanted habitual behaviours, for example using a diary to record behaviour (e.g., Quinn et al., 2010; Wood, Tam, & Witt, 2005). Learning about their own idiosyncratic cues to habits would enable people to anticipate when they need to monitor their behaviour to stop themselves from performing an unwanted habit.

As we have outlined, implementation intentions can create new behavioural responses. In this way, implementation intentions offer a potential means to specify new cue-responses that will compete with unwanted habits (e.g., Chatzisarantis & Hagger, 2007; Verplanken, 2005). Evidence around the effectiveness of implementation intentions working against habits is mixed. Some studies have found that implementation intentions can overcome established habits (Bamberg, 2000; Holland, Aarts, & Langendam, 2006; Tam, Bagozzi, & Spanjol, 2010), and others have observed that they only work at lower levels of counterintentional habit strength (Webb, Sheeran, & Luszczynska, 2009; Aarts & Dijksterhuis, 2000).

Both implementation intentions and habits are thought to operate through automatic processes. It has therefore been suggested that the mechanism through which an implementation intention would break a habit would be the automaticity associated with the action specified in the implementation intention plan overriding habit-related automaticity (Verplanken, 2005). There is however little evidence to suggest that this is the case. Rather, it is more likely that when the two conflicting automatic responses are activated in memory this results in the conflict being brought into consciousness so that behaviour is subsequently guided by deliberative processes. Neuroimaging studies have shown that when multiple potential automatic responses are activated, the anterior cingulate cortex is activated and this leads to activation of the prefrontal cortex which is involved in more deliberative guiding of actions (Botvinick, Braver, Barch, Carter, & Cohen, 2001; Yeung, Botvinick, & Cohen, 2004). At this point, reasoned cognitions (such as attitudes) become important in addition to people's ability to exert self-control. This idea is tentatively supported by data from a laboratory study of routinised decision making (Betsch, Haberstroh, Molter, & Glockner, 2004). Participants formed implementation intentions to perform an alternative action to that which they had routinised. Under time pressure, participants were able to override routine responses on 30% of occasions, in comparison to 70% when not under pressure. This suggests that self-regulatory resources were required for participants to override their routine responses once the implementation intentions had brought the choice under conscious control. However this conclusion is limited by the lack of a control group who did not form implementation intentions. Nonetheless, these findings suggest that implementation intentions may support performance of a new desired behaviour and inhibition of an old unwanted habit by bringing the decision between the two options to consciousness at the appropriate decision point. It is important to ensure that intentions to perform new behaviours remain stable and prioritised over competing goal intentions, so that the new behaviour remains desirable at the decision point (Adriaanse, Gollwitzer, de Ridder, de Wit, & Kroese, 2011).

Mental contrasting involves focusing on a desired future state and comparing this with the present reality that obstructs realisation of this state. Adriaanse et al. (2010) found that participants who formed implementation intentions and also used mental contrasting were more successful at reducing their unhealthy snacking over the following week than were those who formed implementation intentions alone or those who did not make plans. The former group showed a clearer understanding of their cues for unhealthy snacking and this may be why they were then more able to form plans which targeted these situations. More work is needed to investigate this but Adriaanse, Oettingen et al.'s findings suggest that mental contrasting may be a useful approach to help identify people's cues to behaviour.

Summary and conclusion

Focusing behaviour change interventions on the formation of health-promoting habits has the potential to enable interventions to have a sustained long-term impact on behaviour and health. When designing behaviour change interventions, it is important to focus both on disrupting existing undesirable habits and developing new desirable habits. This paper has suggested some ways in which this can be achieved.

We advocate self-monitoring and planning both for identifying appropriate contexts in which new health-promoting behaviours may be performed, and for anticipating and inhibiting possible actions that may hinder continued enactment of new behaviours. Implementation intentions can be effective in both respects.

When planning to form a new habit there are numerous potential cues people could choose to use. If a number of features of a situation may be chosen to cue a behaviour, we recommend choosing the most salient cues, and those to which attention is drawn in the flow of people's daily lives. We advise continued self-monitoring of behaviour and positive feedback to encourage satisfaction with changes and motivate continued repetition. Satisfaction may also be boosted by ensuring realistic prior outcome expectancies, or focusing on previously undervalued positive outcomes.

The easiest behaviours to make habitual are likely to be those that are simple, with existing salient cues that occur at task completion rather than in the middle of another task. If external rewards are to be given for performance, habits will be more likely to form if rewards are not experienced as contingent on behaviour, so that they do not become the focus of performance. Habit formation does not require extrinsic rewards where people are intrinsically motivated, and intrinsic motivation can be bolstered through praise and encouragement, and the support of a mentor to whom the actor can relate.

Unwanted habits can be broken by restructuring personal environments, or programming new responses to existing environments. Where purposive context change is unfeasible as an intervention strategy, we recommend intervening at a point when people are changing the environments in which they live or work. Within existing environments, monitoring habitual activity can reveal cues to existing habits, in turn facilitating reduced exposure to cues to unhealthy habits, or implementation of health-promoting alternative responses. Placing reminders in the environments where unwanted habits are performed can provide a useful reminder of an intention to implement an alternative response.

It will not always be possible to include all these recommendations in a single intervention. Nonetheless, consideration of the habit formation process could help behaviour change attempts have an impact beyond the intervention period.

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