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To cite this article: Junilla K. Larsen & Gareth J. Hollands (2021): Targeting automatic processes to reduce unhealthy behaviours: a process framework, Health Psychology Review, DOI: [10.1080/17437199.2021.1876572](https://doi.org/10.1080/17437199.2021.1876572)

To link to this article: <https://doi.org/10.1080/17437199.2021.1876572>



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Published online: 25 Jan 2021.



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Targeting automatic processes to reduce unhealthy behaviours: a process framework

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ABSTRACT

While previous frameworks to address health behaviours through targeting underlying automatic processes have stimulated an improved understanding of related interventions, deciding between intervention strategies often remains essentially arbitrary and atheoretical. Making considered decisions has likely been hampered by the lack of a framework that guides the selection of different intervention strategies targeting automatic processes to reduce unhealthy behaviours. We propose a process framework to fulfil this need, building upon the process model of emotion regulation. This framework differentiates types of intervention strategies along the timeline of the unfolding automatic response, distinguishing between three broad classes of intervention strategies – direct antecedent, indirect antecedent, and response-focused. Antecedent-focused strategies aim to prevent the exposure to or activation of automatic responses directly through the avoidance of unwanted stimulus-response associations (i.e., situation modification or situation-specific response selection), or indirectly through automatising self-control (i.e., attentional deployment or cognitive change). Response-focused strategies aim to directly downregulate automatic unwanted responses (i.e., response modulation). Three main working hypotheses derived from this process framework provide practical guidance for selecting interventions, but await direct testing in future studies.

ARTICLE HISTORY

Received 29 July 2020
Accepted 7 January 2021

KEYWORDS

Automatic processes;
intervention techniques;
health behaviours; addiction;
impulsivity; self-control

In recent years, an increasing emphasis has been placed upon the central importance of targeting ‘automatic’¹ processes for changing human health behaviours to prevent disease (Marteau et al., 2012). This is reflected for instance in evidence that interventions that alter environmental cues and underlying automatic processes, defined as habits, impulses, hedonic goals or stereotypic associations (Papies, 2017), appear to have more and broader impact on human health behaviours than do traditional educational approaches that mostly reach higher socioeconomic status populations (McGill et al., 2015). People are often ‘seduced’ by omnipresent palatable cues in their environment. These cues can trigger automatic responses that interfere with the enactment of healthy behaviours. For instance, seeing or smelling palatable food may result in sudden food cravings and unplanned food consumption. An important challenge lies in intervening on these substantially, even wholly, automatic processes. While previous frameworks to address health behaviours through targeting underlying automatic processes have stimulated an improved understanding of related interventions (Friese et al., 2011; Hollands et al., 2016; Papies, 2017), deciding between intervention strategies often remains essentially arbitrary and atheoretical. Making considered decisions

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has likely been hampered by the lack of a framework that guides the selection of different intervention strategies targeting automatic processes to reduce unhealthy behaviours. We propose a process framework to fulfil this need. Three main working hypotheses derived from this process framework provide practical guidance for selecting interventions, but await direct testing in future studies. The framework is in line with a ‘personalized medicine’ approach towards health (i.e., precision public health) that aims to provide ‘the right intervention to the right population at the right time’ (Khoury et al., 2016). As such, it offers ways to help researchers and practitioners consider when less is enough and more is not more effective for some people, whereas for others more intensive intervention is needed. This fits well with recent prominent policy perspectives (GjØdsbøl et al., 2019; Tarkkala et al., 2019). It is intended that this new framework can provide promising future avenues for selecting and testing future health intervention strategies that may bridge often reported intention-behaviour gaps, singly and in combination with one another.

A process model of intervention techniques targeting automatic processes

Figure 1 summarises our conceptual process framework of intervention techniques targeting automatic processes, build upon the process framework of emotion regulation (Gross, 1998, 2001). Notably, our main goal is *not* the specification of *when* interventions are automatic (Hollands et al., 2016), nor to contribute another framework categorising different intervention techniques. There are abundant better alternatives of well-developed frameworks to precisely categorise techniques, including the Behaviour Change Technique (BCT) Taxonomy (Michie et al., 2013) and the recent Typology of Interventions in Proximal Physical Micro-Environments (TIPPME) (Hollands et al., 2017). Compared to these frameworks, our categorisation is necessarily an oversimplification. Our goal is instead to propose a process framework that guides the selection of different intervention strategies targeting automatic processes to reduce unhealthy behaviours (i.e., discourage or decrease automatic enactment or performance of a behaviour with negative health consequences).

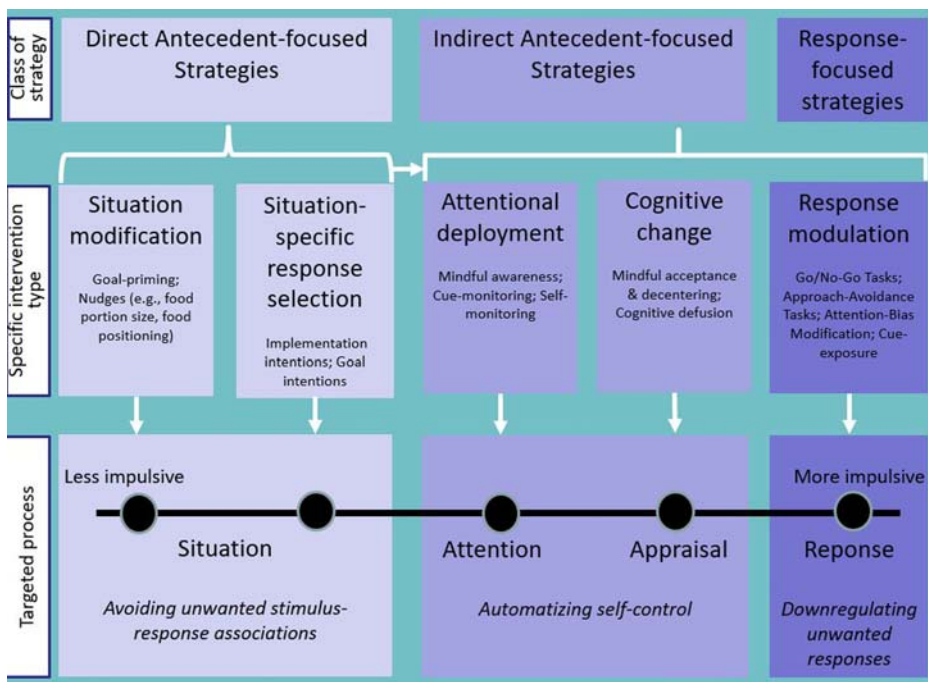


Figure 1. A process model of intervention techniques changing automatic processes, inspired by the process model of emotion regulation. Note: The exemplar antecedent and response-focused intervention strategies are not meant to be exhaustive.

To facilitate this goal, our framework categorises strategies according to how and for whom they target automatic processes. We also include intervention strategies that target reduction of unhealthy behaviours by encouraging healthier behaviours. If health professionals (i.e., clinicians and/or researchers) aim to help people who experience problems with translating health intentions into behaviours, our framework may provide initial guidance that helps in selecting strategies with the potential to bridge this intention-behaviour gap.

This model differentiates types of intervention strategies along the timeline of the unfolding automatic response. Intervention strategies can operate at different 'levels' of this unfolding response. At the broadest level, we distinguish between antecedent-focused and response-focused intervention techniques. Antecedent-focused strategies aim to prevent the exposure to or activation of automatic unwanted responses. In contrast, response-focused strategies aim at directly downregulating automatic unwanted (i.e., impulsive) responses. We further distinguish between two sub-forms of antecedent-focused strategies: Direct and indirect. Direct antecedent-focused strategies aim to prevent automatic unwanted responses directly through the avoidance of specific unwanted stimulus-response associations. This can be done by modifying situations (e.g., putting a fruit bowl at the table) to facilitate goal responses or by selecting different situations, through for instance forming goal intentions (e.g., not going to the supermarket when being hungry) and/or implementation intentions (e.g., 'If I am hungry, I am going to cook a healthy meal instead of going to a fast-food restaurant'). Moreover, indirect antecedent-focused strategies aim to (further) change these automatic responses through the reinforcement of the ability to self-control by automatising self-control and executive functioning. This can be done by attentional deployment (e.g., paying mindful attention to eating a meal) or cognitive change (e.g., using decentring techniques where people are instructed to look at the food images and think about their reactions to foods as constructions of the mind, which appear and disappear). Finally, response-focused strategies aim directly at downregulating automatic unwanted (i.e., impulsive) responses through response modulation and directly changing automatic associations, attentional biases and approach-avoidance tendencies (e.g., cognitive bias modification procedures to change reactions to cues). Importantly, strategies are not 'limited' to their first and main proposed working mechanism. They may eventually also change other mechanisms during the unfolding automatic response. For instance, direct antecedent-focused strategies that work principally through the avoidance of specific unwanted stimulus-response associations may eventually, when proven successful, also begin to automatise self-control and in the long term may even break old habits when new ones have been formed.

Three main hypotheses can be derived from our process framework that provide practical guidelines for intervention selection. First, direct antecedent-focused strategies work better for individuals who are less impulsive, while response-focused strategies work better for those who are more impulsive. Second, if direct antecedent-focused strategies are successful, it might not make sense to expose people to response-focused strategies to downregulate further responses as well (i.e., searching for interaction) because people do not need to train changes in the underlying processing of cues they are no longer (i.e., physically or mentally) affected by. Third, direct antecedent-focused strategies (i.e., situation modification and situation-specific response selection) may be used to initiate and maintain performance on indirect antecedent-focused or response-focused intervention strategies (e.g., prompting people to apply mindfulness strategies).

In the following sections we outline and discuss different types of antecedent-focused and response-focused strategies. We have used key exemplar intervention techniques of direct antecedent-focused (i.e., goal priming and implementation intentions), indirect antecedent-focused (i.e., mindfulness) and response-focused (i.e., Go/No-Go tasks) strategies to illustrate our process framework. These exemplar intervention techniques were chosen based on their potential as effective 'stand-alone' interventions, rather than as 'adjunct' interventions to established treatments (Wiers et al., 2018), for altering unhealthy behaviours and bridging intention-behaviour gaps through changes in automatic processes. Notably, under each class of strategies, these are presented as

example approaches within a much wider range of possible strategies (see also [Figure 1](#)). The defining characteristic of these strategies is that they target automatic processes, rather than that they are necessarily designed to be engaged with automatically. For example, implementation intentions and mindfulness interventions likely initially require conscious engagement with their content, but are considered exemplar intervention techniques as they influence behaviour through substantially automatic processes. We will first discuss state-of-the art research with regard to these exemplar techniques, paying explicit attention to potential moderators and mechanisms, also referring to the first two hypotheses. Then, we provide illustrative example evidence of whether and how direct antecedent-focused interventions may activate the use and maintenance of other interventions (i.e., the third hypothesis). We end this paper with a general discussion and recommendations for future research.

Direct antecedent-focused strategies

Situation modification: goal priming

Goal priming refers to the provision of health-related cues or primes to influence automatic attention, using external situational cues to activate a health goal and to avoid unhealthy stimulus-response associations, thus shifting attention towards goal-relevant stimuli (Papies, 2017). With 'goal priming' we refer to situation modification (see [Figure 1](#)), specifically 'labelling' and 'prompting' actions activating people's health goals, including communication of explicit textual, numeric, or pictorial information, in accordance with the TIPPME framework (Hollands et al., 2017). Other exemplar techniques categorised and summarised by the TIPPME framework (Hollands et al., 2017) that work through changes made in the environment are interventions based on sizing (e.g., food portion sizes) and placing (e.g., proximity of healthy dietary products). These interventions elicit their effects mostly outside people's consciousness, with people often not being aware of the external stimulus (the intervention) or their resulting behaviour. As they rely less on reflective conscious engagement, they probably have a more significant potential for changing behaviour across populations (Hollands et al., 2016).

In line with a normative framework (Herman & Polivy, 2008), we propose that particularly the normative types of 'situation modification' techniques (e.g., portion size) may affect everyone, while the more 'goal-dependent' types (e.g., goal priming) have a more powerful effect on subgroups of people motivated to change health behaviours, given that a goal-dependent act is one that depends on its goal for its occurrence (Moors & De Houwer, 2006). Specifically, goal priming facilitates avoidance of unhealthy stimulus-response associations by increasing focus on prime-congruent goal items or cues (i.e., referring to the specific underlying working mechanism of goal-priming) (Van der Laan et al., 2017). It is thus not surprising that diverse studies have shown effects of goal primes on healthy eating consumption behaviours (e.g., buying more healthy snacks when primed with healthy images) specifically among subgroups of dieters, restrained eaters or people with overweight (Papies & Hamstra, 2010; Stämpfli et al., 2017; Stämpfli & Brunner, 2016). These findings are further supported by meta-analyses (Buckland et al., 2018; Weingarten et al., 2016), suggesting that priming effects are goal dependent and thus only work when the primes are motivationally and goal-relevant for people.

Situation-specific response selection: implementation intentions

The formation of 'implementation intentions' ('if-then-plans') is a widely used strategy to help people achieve their goals (Carrero et al., 2019) and to decrease their existing unwanted habits by forming new replacement plans (Adriaanse & Verhoeven, 2018; Adriaanse, van Oosten, et al., 2011). That is, people formulate specific situations (and potential cues they encounter) by way of the 'if' status (e.g., 'IF I get out of bed at 8 am'), and their desired (i.e., healthier replacement) reaction

by way of the 'then' statement (e.g., 'THEN I will first go for a walk'). Implementation intentions have been proposed to influence behaviour in two rather 'automatic' ways (Gollwitzer, 1999): (1) increasing the accessibility of the mental representation of the anticipated environmental cue (Aarts et al., 1999) and (2) strengthening the link between the planned situation and the goal-directed response (Webb & Sheeran, 2007). These mechanisms call on automatic processes to secure goal attainment specifically (Gollwitzer, 1999). We include the formation of implementation intentions as a specific case of 'situation-specific response selection', given the focus of this strategy on cueing by situational features and increasing access to the mental representation of anticipated cues and subsequent cue-action links. By way of implementation intentions, people use relatively simple tasks that do not require repeated or intensive training of stimulus-response associations (as in response-focused tasks). Importantly, the previously existing unwanted stimulus-response associations remain (i.e., are still equally strongly related to the critical situation) and are thus not directly downregulated or changed via the formation of implementation intentions (Adriaanse, Gollwitzer, et al., 2011). As such, forming implementation intentions is similar to other (direct) antecedent-focused strategies (e.g., goal priming) that prevent the exposure to or activation of automatic unwanted responses by increasing focus on goal cues and goal-cue action links.

Formation of implementation intentions has yielded promising effects on diverse health behaviours, including healthy eating and alcohol consumption (Adriaanse, Vinkers, et al., 2011; Turton et al., 2016; Vila et al., 2017). Meta-analyses have on average reported medium effects of implementation intentions on health-related behaviours (Carrero et al., 2019; Gollwitzer & Sheeran, 2006). However, effects may vary as a function of behaviours targeted, individual characteristics and intervention conditions. To date, the use of implementation intentions has a significantly larger effect for individuals with higher than lower motivation to perform goal-directed behaviour (Hagger & Luszczynska, 2014; Prestwich et al., 2014), for individuals lower compared to higher in impulsivity (Churchill & Jessop, 2010; Churchill & Jessop, 2011; Hagger & Luszczynska, 2014), for healthy than unhealthy behaviours (Carrero et al., 2019), and for single and specific if-then plans than multiple and complex plans (Carrero et al., 2019; Forcano et al., 2018). Thus, evidence on moderating factors clearly shows that 'healthy' and 'simple' implementation intentions seem to work best among 'highly motivated' individuals, similar to goal priming. Moreover, the moderating effects of impulsivity are in line with the first hypothesis of our conceptual model (i.e., 'direct antecedent-focused strategies work better for individuals who are less impulsive, while response-focused strategies work better for those who are more impulsive').

Moreover, findings of three studies are rather unanimous in their conclusion that combining the use of simple and specific implementation intentions with a Go/No-Go task (i.e., response-focused strategy) did *not* lead to additive effects on reduction of self-selected portion size of palatable food or amount of weight loss (Van Koningsbruggen et al., 2013; Veling et al., 2014). These findings are in line with the second hypothesis of our conceptual model, suggesting that if (single, specific and healthy) implementation intentions are successful, it might not make sense to expose people to response-focused strategies to downregulate further responses as well (i.e., searching for interaction) because people do not need to train changes in the underlying processing of cues they are no longer (i.e., physically or mentally) affected by.

Indirect antecedent-focused strategies

Attentional deployment & cognitive change: mindfulness

The aim of mindfulness-based interventions is to increase a state or meta-cognitive perspective of mindfulness in which people learn to experience present moment experiences with awareness and non-judgment or acceptance (Creswell, 2017). Mindfulness contributes to changes in automatic responding (Kang et al., 2013; Lueke & Gibson, 2015). There are many forms of mindfulness interventions with different durations, ranging from 3-months retreats to very brief mindfulness

interventions with a duration of 30 min or less on any occasion and ranging no longer than 4 weeks (Creswell et al., 2019; Howarth et al., 2019). Despite the well-known effects of mindfulness on mental health states, recent studies have shown that mindfulness can also improve physical health and health-related (addictive) behaviours, with changes in mindfulness linked to better outcomes (Alsubaie et al., 2017; Creswell et al., 2019).

Mindfulness is a multicomponent treatment. Three components that might particularly exert effects are *awareness* (i.e., continuously monitoring one's momentary experiences), *acceptance* (i.e., letting experiences come and go without judging them) and *disidentification or decentering* (i.e., distinguishing oneself as separate from the experiences). Recent randomised controlled trials (RCTs) provide promising evidence that *awareness* (i.e., *monitoring*) combined with *acceptance* skills training may be a necessary component for particularly decreasing *stress* ratings, objective stress measures and boosting positive emotions in daily life compared to monitoring alone (Chin et al., 2019; Lindsay et al., 2018; Lindsay & Creswell, 2019). In contrast, *acceptance* provides limited effects as a skill to cope with *cravings* (Tapper, 2017, 2018). To deal with *cravings* (i.e., food) and resultant health behaviours *disidentification* (i.e., *decentering*) proves to be a promising strategy (Keesman et al., 2017; Papiés et al., 2016; Tapper & Turner, 2018). While reason-based paradigms may be a 'losing a battle with urges', mindfulness-based strategies may be paramount to dealing with reward-based learning to change addictive health behaviours (Brewer, 2019).

Mindfulness-based strategies act on both attentional deployment and cognitive change (see Figure 1). They particularly target automatic attention and cognitive flexibility (Leyland et al., 2019; Mak et al., 2018; Moore & Malinowski, 2009). Mindfulness seems to strengthen top-down cognitive control over attentional bias and physiological indices of cue-reactivity (Froeliger et al., 2017; Garland et al., 2017), also reflected in increased prefrontal activation to 'regulate' subcortical brain networks in a goal-directed manner (Froeliger et al., 2017; Garland & Howard, 2018). In line with our framework, mindfulness training may thus target automatic processes underlying health behaviours by increasing (i.e., automatising) healthy habitual responding and self-control over unhealthy stimulus-response (e.g., conditioned) associations (Brewer, 2019; Galla & Duckworth, 2015; Hanley & Garland, 2019).

Response-focused strategies

Cognitive bias modification (CBM) tasks are considered response-focused intervention strategies that consistently modify (i.e., downregulate) targeted biases and unwanted stimulus-response associations (Jones & Sharpe, 2017). They work best for people with higher impulsive addictive approach tendencies (Eberl et al., 2013; Weckler et al., 2017), in line with the first hypothesis of our conceptual model (i.e., 'response-focused strategies work better for those who are more impulsive'). CBM tasks have small effects on cognitive bias and relapse rates in alcohol and tobacco use disorders (Boffo et al., 2019; Jones & Sharpe, 2017), but positive effects on biases do not always translate into effects on addiction outcomes (Boffo et al., 2019; Cristea et al., 2016). CBM tasks should not be regarded as effective stand-alone interventions for alcohol problems, but have potential in the clinical context as an add-on intervention to treatment for alcohol use disorder (Wiers et al., 2018). Go/No-Go tasks are considered one eminent exemplary type of CBM training that has shown particular promise for targeting addictive eating patterns (Aulbach et al., 2019).

Go/No-Go tasks

Go/No-Go tasks focus specifically on the inhibition of motor responses to pictures of palatable cues (e.g., smoking, alcohol or high-calorie food pictures). Participants are thus trained to withhold their response to attractive cue pictures (e.g., of palatable food). Reviews and meta-analyses have provided evidence that Go/No-Go training can positively influence addictive health behaviours (Allom et al., 2016; Aulbach et al., 2019; Jones et al., 2016; Turton et al., 2016), and thus particularly

eating behaviours (Aulbach et al., 2019). Moreover, recent field studies from the field of eating behaviours suggest that insights from laboratory Go/No-Go studies might be translated to clinical settings (Chen et al., 2018a; Preuss et al., 2017; Turton et al., 2018), although higher powered, longitudinal within-subjects studies are still needed (Carbine & Larson, 2019; Veling et al., 2020).

Go/No-Go training does *not* seem to strengthen ‘top-down’ self-control, but mainly works through bottom-up changes in stimulus-response associations (Veling et al., 2017). Repeatedly not responding to a cue may create bottom-up stop-associations with the trained food items (i.e., stimulus-stop contingencies), with no/go stimuli directly triggering behavioural inhibition as in a ‘learned reflex’. Moreover, the continuous withholding of responses to attractive cues may also produce conflicts and negative affect, that eventually may lead to devaluation of the initial targeted cues. To date, several studies have shown evidence for lower evaluations of trained No-Go compared to Go and/or untrained pictures, interpreted as evidence for devaluation (Chen et al., 2016, 2018a; Houben et al., 2012; Quandt et al., 2019; Scholten et al., 2019; Veling et al., 2013). However, some recent studies found that the effects of Go/No-Go training were smaller for rewarding stimuli and stronger for aversive or neutral stimuli (Chen et al., 2019; De Pretto et al., 2019), which is in apparent contrast with a cue-devaluation mechanism of rewarding cues. Thus, it is so far unknown which of the specific bottom-up ‘working’ mechanisms (i.e., stimulus-stop contingencies or cue devaluation) are important, but both clearly refer to automatic changes and downregulation in stimulus-response associations, in line with our framework (see Figure 1).

Direct antecedent-focused strategies support other intervention strategies

Diverse studies have shown consistent effects of forming implementation intentions on Go/No-Go trainings (Brandstätter et al., 2001; Burkard et al., 2013; De Pretto et al., 2017; Gawrilow & Gollwitzer, 2008; Lengfelder & Gollwitzer, 2001; Scholz et al., 2009). For instance, one study found that children with ADHD who formed an inhibition goal with implementation intentions improved inhibition of an unwanted response on a Go/No-Go training (Gawrilow & Gollwitzer, 2008). Similarly, another study found that performance on Go/No-Go trainings could be improved after forming implementation intentions among general adult participants among whom stress was being experimentally manipulated: Stress impaired go no-go performance only in the group *not* instructed to use implementation intentions (Scholz et al., 2009). Moreover, primes of smoking-related backgrounds might also help smokers to be more accurate (i.e., making fewer mistakes) on Go/No-Go trainings (Detandt et al., 2017). These findings suggest that direct antecedent-focused strategies (e.g., implementation intentions or priming) may support performance on response-focused intervention strategies (e.g., Go/No-Go trainings), in line with the third hypothesis of our conceptual model.

Moreover, direct antecedent-focused intervention strategies might also facilitate the *initiation* of indirect antecedent-focused or response-focused intervention strategies. In one illustrative study, self-compassion priming resulted in higher willingness to engage in mindfulness training through increased state mindfulness (Rowe et al., 2016). Formation of implementation intentions has also shown to increase attendance for psychotherapy (Sheeran et al., 2007) and can help patients achieve their goals (Duhne et al., 2020). The need to examine whether and how direct antecedent-focused strategies might engage initial use of response-focused intervention strategies is warranted and forms an important avenue for future research.

General discussion

The choice for deciding between different intervention strategies targeting automatic processes underlying health behaviours is still often arbitrary and has been hampered by the lack of a practical framework categorising such strategies according to how they target automatic processes. We propose a process framework to fulfil this need that distinguishes between three classes of intervention strategies. Although previous frameworks have stimulated improved understanding,

development and evaluation of interventions that target automatic processes (Friese et al., 2011; Hollands et al., 2016; Papies, 2017), our model is the first to propose a process model of intervention techniques that specifies differential mechanisms along the unfolding automatic response. Given the focus on intervention strategies targeting automatic processes to change unhealthy behaviours and related intention-behaviour health gaps, our conceptual model may particularly be important for disadvantaged (e.g., lower educated) groups that often experience more problems with translating intentions into behaviours (Schüz et al., 2017; Schüz et al., 2020).

The model builds upon the process model of emotion regulation (Gross, 1998, 2001). It distinguishes between the following three types of strategies: (i) direct antecedent-focused interventions that focus on the avoidance of unwanted stimulus-response associations (ii) indirect antecedent-focused interventions that also focus on the avoidance of unwanted stimulus-response associations but do so through automatising self-control, given promising effects of effortless self-control (Gillebaart & de Ridder, 2015); and (iii) response-focused interventions that focus directly on changing (i.e., downregulating) automatic associations, attentional biases, and approach-avoidance tendencies. We used four exemplary, principal and seemingly effective, types of intervention strategies (i.e., goal priming, implementation intentions, mindfulness and Go/No-Go tasks) that illustrate these three different types of strategies. Notably, similar type of strategies have been used in the mental health domain. For example, forming implementation intentions (i.e., direct antecedent-focused strategies) may prevent mental health problems by focusing on goals (Toli et al., 2016). Mindfulness-based strategies (i.e., indirect antecedent-focused strategies) improve mental health and prevent depressive relapse by automatising self-control (Kuyken et al., 2016; Spijkerman et al., 2016). Finally, CBM techniques (i.e., response-focused strategies) are used to change perception of stimuli in depression and anxiety disorder (Fodor et al., 2020; Loijen et al., 2020). Thus, our process framework might also be readily translatable to mental health intervention domains.

Our process model proposes strategies that operate at some point during the unfolding automatic response, and, we present the three classes of intervention strategies (i.e., direct antecedent, indirect antecedent and response-focused) as distinct approaches. However, as mentioned, this does not mean that strategies are limited by their first and main working mechanism within the unfolding automatic response. This might particularly apply to the different forms of antecedent-focused strategies (i.e., direct or indirect) that both aim to prevent the exposure to or activation of automatic unwanted responses. For instance, forming implementation intentions may directly assist in the avoidance of unwanted stimulus-response associations, but may also do so indirectly by automatising self-control (Friese et al., 2011; Gillebaart & de Ridder, 2015). In the end, when the use of implementation intentions is successful and new habits have been formed, then the old unwanted habits and underlying stimulus-response associations may theoretically even change. Thus, we placed intervention strategies by reference to their key proposed mechanism of effect (i.e., similar to the first mechanism arising during the unfolding automatic response). The conceptual process model (Figure 1) distinguishing between these three broad classes of interventions is thus necessarily an oversimplification, but provides a general framework for deepening our understanding of the automatic mechanisms involved.

Reflection on the three main hypotheses

Our process model resulted in the formulation of three main hypotheses that provide practical guidelines for intervention selection. In line with our first hypothesis (i.e., direct antecedent-focused strategies work better for individuals who are less impulsive, while response-focused strategies work better for those who are more impulsive), direct antecedent-focused strategies (i.e., implementation intentions) were indeed found to be more successful for motivated individuals lower in impulsivity (Churchill & Jessop, 2010; Churchill & Jessop, 2011; Hagger & Luszczynska, 2014), whereas response-focused strategies were more effective for more impulsive and approach-biased individuals (Eberl et al., 2013; Weckler et al., 2017). Moreover, a recent study

among individuals with eating disorders (i.e., bulimia nervosa and binge eating disorder) – who are commonly more impulsive than non-eating disordered individuals (Waxman, 2009) – evaluated individuals' feedback and experiences with both implementation intentions and Go/No-Go tasks, finding that 'implementation intentions' were less acceptable than Go/No-Go tasks (Chami et al., 2020). This accords with the idea that simpler forms of 'direct antecedent-focused' strategies are insufficient for individuals with more impulsive, and probably also more addictive and disordered, characteristics. Although more research testing (other) individual moderating characteristics of (additional) techniques is needed, these findings provide some useful suggestions for tailoring different intervention types to individual 'impulsivity' traits, impulsivity being a characteristic feature of addiction (Kotov et al., 2010). This first hypothesis may thus stimulate further research examining how tailoring of intervention strategies to individual 'impulsivity' and 'impulsivity-related' characteristics can be optimised.

In line with the second hypothesis of our conceptual model (if direct antecedent-focused strategies are successful, it might not make sense to expose people to response-focused strategies to downregulate further responses as well), findings of three studies are rather unanimous in their conclusion that combining the formation of simple and specific implementation intentions (i.e., direct antecedent-focused strategies) with Go/No-Go tasks (i.e., response-focused strategies) did not lead to additive effects on reduction of self-selected portion size of palatable food or amount of weight loss (Van Koningsbruggen et al., 2013; Veling et al., 2014). People probably do not need to train changes in the underlying processing of cues they are no longer (i.e., physically or mentally) affected by. It should be noted, however, that studies all refer to one similar exemplary combination of strategies (i.e., implementation intentions and Go/No-Go tasks). Given the scarcity of studies evaluating such combined intervention techniques, these findings should be seen as working hypotheses to further test in future randomised controlled trials.

Finally, we hypothesised that direct antecedent-focused strategies may be used to initiate and maintain performance on other intervention strategies (i.e., the third hypothesis of our conceptual model). In line with this hypothesis, forming implementation intentions consistently supported performance on Go/No-Go tasks (Brandstätter et al., 2001; Burkard et al., 2013; De Pretto et al., 2017; Gawrilow & Gollwitzer, 2008; Lengfelder & Gollwitzer, 2001; Scholz et al., 2009) and similar effects for priming have been reported (Detandt et al., 2017). Notably, a promising theory-based view of CBM (i.e., ABC training) involves repeated training of stimulus-response downregulation away from addictive cues towards personalised goal-relevant 'approach' behaviours (Wiers et al., 2020). We suggest that antecedent-focused strategies might be used to assist the initial choice for and support of goal-relevant 'approach' behaviours in 'response-focused' CBM trainings. Another promising area of future research is to examine whether direct antecedent-focused strategies also facilitate the *initiation* of other interventions in real-life contexts. There is some preliminary support for this suggestion (Duhne et al., 2020; Rowe et al., 2016; Sheeran et al., 2007). Future research should further examine whether and how direct antecedent-focused strategies (e.g., implementation intentions or goal priming) may support the initiation of other intervention strategies, particularly in reaction to feelings of craving (e.g., 'If I experience craving, then I will perform the Go/No-Go task'). We suggest that this is an important future research avenue as it may break the automatic link between the cue (e.g., smelling a cigarette or experiencing craving or stress) and the behaviour (e.g., smoking) through the development of new stimulus-response associations (Larsen, Kremers, & Vink, [manuscript submitted for publication](#)), in addition to further response-focused specific intervention effects.

Further future directions

Notably, in contrast to the absence of interaction effects when combining direct-antecedent and response-focused strategies, interaction effects have been reported when combining other types of techniques. For instance, a systematic review suggests that a combination of 'priming' and

'salience' nudges (i.e., both direct-antecedent focused strategies) influences healthier choices (Wilson et al., 2016). We suggest that future research requires more specific and precise demarcation of the conditions under which techniques might have combined effects. Our categorisation may offer guidance on the most likely mechanisms involved in (combining) different types of techniques, facilitating further thinking on the existence or absence of interaction effects between specific types of techniques.

Moreover, some recent theoretical accounts propose that propositional processes (e.g., 'appraisals') play a role in (further) stimulus-response downregulation (De Houwer et al., 2020; Van Dessel et al., 2018, 2019), supported by studies showing that the awareness of stimulus-action contingencies moderates effects of cognitive bias modification (CBM) trainings (i.e., more aware – more effects) (Hofmann et al., 2010; Van Dessel et al., 2016). As such, interventions that stimulate awareness may thus further increase effects of response-focused strategies. Mindfulness strategies might increase momentary awareness and engender less effortful response inhibition (Andreu et al., 2018). There appears to be some preliminary synergistic support from studies combining mindfulness and response-focused strategies (Fisher et al., 2016; Forman et al., 2016) and there is more research underway testing similar combined effects (Chen et al., 2018b). Future research may further examine these theoretically promising additive effects between response-focused and indirect-antecedent focused strategies.

Conclusion

We propose a new process framework for categorising intervention techniques targeting wholly automatic processes that may help clinicians and researchers decide which types of intervention strategies are most promising given individual's characteristics. For researchers specifically, when no former information is given about individual characteristics (e.g., impulsivity), one may start with direct antecedent-focused strategies for all participants and randomise participants to further strategies based on the effectiveness of former outcomes (i.e., sequential intervention allocation), given that direct-focused strategies are often less resource intensive compared to the other types of strategies. Notably, interventions that combine strategies targeting more reflective (e.g., attitudes or self-efficacy) and automatic processes show promise for changing health behaviours (Friese et al., 2011). Nevertheless, given the abundant amount of socio-cognitive models, our conceptual model focuses on automatic processes and offers a way to help researchers decide about when less is enough (i.e., when direct antecedent-focused strategies are effective) and more is not more effective here (i.e., counter the tendency to throw the kitchen sink into every intervention). The purpose of this piece is to contribute to a solid, theoretically-grounded foundation for generating further understanding for how (combined) intervention techniques might most effectively target automatic processes to improve health.

Note

1. Although automaticity is an umbrella term encompassing many different facets and conceptualisations, it can function usefully if researchers specify in what sense they believe a process to be automatic (Moors & De Houwer, 2006).

Acknowledgements

We would like to thank Esther Papies, Paschal Sheeran and Denise de Ridder for their helpful comments.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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