Automatic Processes and Self-Regulation of Illness

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Abstract

Research on the Commonsense Self-Regulation Model (CS-SRM) has emphasized reflective/conscious perceptual processes regarding illness threat (beliefs about symptoms, consequences, timeline and curability) in predicting and changing coping behaviours. Understanding of illness self-regulation and avenues for intervention might be enriched by consideration of automatic processes that influence the recognition and identification of illness, response to illness, and ongoing management. This article adopts an integrative approach to (1) outline the theoretical importance of implicit processes in patients' self-regulation of illness and methods to study them; (2) review research evidence for these processes, including interventions tested to modify them; and (3) outline avenues for future research. A substantial body of research on implicit processes (cognitive bias and interpretational bias) in illness maintenance in chronic illness has recently been extended to detection and interpretation of acute illness and new perspectives relating to the self-system. There is encouraging evidence that cognitive accessibility of coping and implicit attitudes may impact upon coping behaviours. Procedures that strategically automatize coping responses and create habits have considerable promise. We outline an agenda for future research in which health psychology accepts the challenge posed by the interplay of the reflective and associative systems in promoting effective self-regulation of illness.

Keywords: Commonsense Model of Self-Regulation, illness cognition, automatic processes, action planning, habit

Automatic Processes and Self-Regulation of Illness

The Commonsense Self-Regulation Model (CS-SRM; Leventhal, Meyer, & Nerenz, 1980; Leventhal, Phillips, & Burns, 2016) is a widely used health behaviour theory that describes the processes involved in identifying that one is ill and in initiating and maintaining a self-regulation process to restore a state of health or mitigate threat. The CS-SRM addresses both *automatic* (i.e., non-conscious, non-deliberative, fast/efficient, implicit, impulsive) and *reflective* (i.e., conscious, deliberative, effortful, cognitively taxing, explicit) factors involved in detection and interpretation of illness threats, formation of illness and treatment representations and action plans, and initiation and maintenance of treatment behaviour(s). Further, the CS-SRM treats these automatic and reflective factors as dynamic and interactive, influencing each other and changing over time and with experience (e.g., illness progression, treatment changes, patient preferences/changes). However, a majority of research efforts regarding CS-SRM processes have focused on measurement of the reflective, cognitive constructs, such as patients' beliefs regarding the illness identity, cause, control, timeline/duration, and consequences, and their beliefs about prescribed medication to predict self-management, treatment adherence and health outcomes (see Hagger, Koch, Chatzisarantis, & Orbell, 2017, and Horne et al., 2013, for recent meta-analyses of these relationships). While there are many important avenues for research regarding reflective CS-SRM processes (see Hagger et al., 2017 and other articles in this issue), we also see potential advancement in theory and healthcare that might be derived from the study of automatic processes in patients' self-regulation of illness.

Whereas consideration of reflective processes in self-regulation provides important information about the ways in which people deliberately guide their actions, psychology also recognizes the important role played by more impulsive, automatic systems in guiding behaviour outside of conscious awareness (see Bargh, 1994; Evans, 2007; Strack & Deutsch,

2004). Conceptual and empirical reviews have sought to identify possible avenues for an implicit-processes research agenda in health and illness behaviour: the very first issue of this journal included an important review of implicit processes that can impact upon health and illness behaviour (Aarts, 2007), such as automatic processes involved in goal activation and pursuit; Sheeran, Gollwitzer, and Bargh (2013) provide an overview of implicit cognition, affect, and motivation and their potential involvement in and effect on health; and a recent special issue of *Health Psychology Review* presents the opportunities for implicit methods in predicting and intervening in health behaviours (Hagger, 2016; Hollands, Marteau, & Fletcher, 2016; Papies, 2016; Rebar et al., 2016). These conceptual articles cite a general paucity of empirical evidence regarding automatic processes in health-related behaviour and an agenda that, to date, focuses primarily on prevention of illness.

We propose that understanding of and intervention in *illness self-regulation* might be enhanced by attention to automatic processes that influence the recognition of illness, identification of illness (labeling), response to illness, and ongoing management. That is, because behaviour is driven at least partially by forces outside of our awareness and conscious intention, evaluating these mechanisms, suggested by the CS-SRM, should improve the ability of research to explain variance in behaviour, to outline conditions under which and for whom behaviour occurs, and to design effective interventions for improving illness management. As recently argued by Hagger et al. (2017), Leventhal et al. (2016) and Phillips, Leventhal, and Burns (2017), researchers need to study dynamic self-regulation processes using new experimental paradigms, including those utilized in the study of implicit processes.

The purpose of this conceptual review is to outline automatic processes that occur in individuals' self-regulation of illness threats and to demonstrate the potential for these processes and associated methodologies for improving researchers' prediction of and

intervention into health and illness-related behaviour and outcomes. We organize the review into two sections, which broadly correspond to the first and second halves of the illness self-regulation process: first, we address topics related to illness schema activation, involved in illness threat detection/recognition and interpretation; and second, we address topics related to the automatic processes involved in coping and illness management. In each section, we cover three main points: first, we describe the relevant, automatic processes involved in that aspect of illness self-regulation. Second, we review empirical evidence regarding these automatic processes, along with the methods used to study them and interventions that have been tested to manipulate these processes. Third, we discuss implications for future research and interventions for addressing known problems in self-regulation of illness (e.g., medically undiagnosed syndromes; delay in symptom identification and care-seeking, non-adherence to medication and rehabilitation). A glossary of key concepts considered in the review, presented in the order in which they arise in the text is provided in Table 1, and Figure 1 illustrates the proposed roles of implicit processes in illness self-regulation.

Automatic Processes in Individuals' Illness-Threat Detection and Interpretation

The CS-SRM proposes that the central route to illness identification involves the detection of somatic, physical or functional deviation that exceeds normally expected variability from an underlying prototype of the usual physical self, shown in the left hand portion of Figure 1. The identification of such variability signals illness (symptom versus benign sensation). Interpretation of this symptomatic experience depends upon matching it to schematically represented information about illness in memory (e.g. Henderson, Hagger & Orbell, 2007). A great deal of evidence of cognitive processes in illness has employed self-report questionnaire measures to sample beliefs about illness (Hagger & Orbell, 2003; Hagger et al., 2017). These methods sample the *explicit products* of cognitive processing rather than *cognitive processing* itself. Implicit cognition research employs experimental

methods to access cognitive structure (e.g. schematic knowledge about illness) and cognitive processes (e.g. attention to particular illness stimuli) that stay outside of a person's awareness. These processes are considered implicit because responses to stimuli occur without a participant intending the response, recognising that the stimulus has affected his or her responses, and in some cases (e.g. subliminal stimulus presentation paradigms) without awareness of the stimulus itself (Bargh, 1994).

Implicit illness cognition research to date has focused on two cognitive processes: *attentional bias,* and *interpretation bias*. Attentional bias refers to the process in which particular stimuli capture a person's attention and is typically measured by modifications of the Stroop (1935) colour naming task or the visual dot probe task (MacLeod, Matthews & Tata, 1986). These tasks detect selection of stimuli for attention shown either by facilitation of responses to those stimuli, or by disruption in responding to other stimuli presented concurrently. Attention bias paradigms that employ modifications of the colour Stroop task require participants to name the font colour of words that are either illness related or neutral control words; the difference in the time taken to name illness versus control words is used to infer attentional bias. Response time latency represents interference in speed of colour naming due to inability to avoid attending to the word meaning in the illness stimuli. If participants are slower to identify the colour of illness related words than neutral words, this is taken as evidence that illness related words captured the attention. In the visual probe task, two words or pictures are presented simultaneously on a computer screen, before a dot, arrow or other probe replaces one word/picture. The participant is required to indicate where on the screen the dot is presented. In modifications of this task to assess illness cognition, one word is illness related and the other neutral. Attentional bias is calculated as the difference in response speed to identify the location of probes that replaced illness words and control words. Response latency to illness words indicates attentional bias, because detection should

be quicker in the attended area of the screen. The inference is that a participant was attending to the illness word when the probe appeared. Variations to these tasks include masking to manipulate conscious awareness of stimuli, and variations in duration of stimulus presentation (stimulus onset asynchrony) to distinguish attentional capture from maintenance of attention. It is also possible to infer attentional avoidance, or a bias to direct attention away from illness words, if a participant is faster to identify the location of probes that replace neutral words (Bradley, Mogg, Falla & Hamilton, 1998; Field & Cox, 2008; Yiend, 2010).

Considerable research addresses attentional biases in participant populations with chronic conditions, including chronic pain (e.g., Crombez, Van Ryckeghem, Eccleston &Van Damme, 2013; Pincus & Morley, 2001), chronic fatigue syndrome (e.g., Hou et al., 2014; Hughes, Hirsch, Chalder & Moss-Morris, 2016), irritable bowel syndrome (e.g. Phillips, Wright, & Kent, 2014), psoriasis (e.g., Fortune et al., 2003), and asthma (e.g., Jessop, Rutter, Sharma & Albery, 2004). Typically this research has compared patient populations with healthy controls to establish (correlational) association between attentional bias and illness behaviour (symptom experience). The rationale for this endeavour is that cognitive processing biases may serve to causally maintain chronic disabling conditions and impede recovery, similar to findings that cognitive biases causally maintain anxiety disorders (MacLeod, Rutherford, Campbell, Ebsworthy & Holker, 2002). Attention to stimuli likely to signal physical harm—pain or fatigue for example—acts as a gatekeeper, prioritizing the detection of harm related stimuli. In relation to pain conditions, Pincus and Morley (2001) concluded that the hypothesis of attention bias towards pain stimuli was unsupported, although counter-intuitive with explicit accounts of pain and clinical observation. A more recent meta-analytic review (Crombez et al., 2013) generally supported this conclusion; reliable evidence of attentional bias was restricted to laboratory studies where participants expected pain in an upcoming task. A review of studies of chronic fatigue syndrome reported

inconclusive evidence (Hughes et al., 2016). However, a recent study addressing previous methodological concerns (Hughes, Chalder, Hirsch & Moss- Morris, 2017) establishes reliable evidence for attentional *maintenance* toward words associated with the condition (e.g., fatigue, drained, housebound). Fortune and colleagues (Fortune et al., 2003) obtained evidence of attentional bias in people with psoriasis, relative to controls, whereas van Beugen et al. (2016) found attentional bias to disease stimuli in participants with alopecia.

Interpretation bias refers to bias in the manner in which people resolve ambiguity and uncertainty in selecting meaning and action (Mathews &Mackintosh, 2000). Contextual information can provide guides to interpretation of stimuli (e.g., feeling sick after a seafood lunch or breathlessness after climbing the stairs having recently seen a television program about heart disease), whereas in the absence of contextual information, individuals rely upon internally generated information from a predominantly accessible schema (e.g., my legs are stiff because there is something seriously wrong with my legs). These processes can and do often occur in conscious awareness, but evidence suggests that they may also arise automatically. A range of tasks including the homophone task, homonym task, the word stem completion task, and the ambiguous scenarios task measure interpretation bias (for review see Hirsch, Meeten, Krahe & Reeder, 2016). Homophones are words that are pronounced in the same way but have different meanings and/or spellings (e.g. pane-pain), whereas homonyms are words that sound the same and have the same spelling but different meanings (e.g. terminal), and word stems refer to parts of words (e.g. ten_) that might be completed in a number of ways (e.g. tender vs. tennis). The ambiguous scenarios task (Mathews & Mackintosh, 2000) presents participants with real life self-relevant scenarios, each starting with a title and ending ambiguously. This is an encoding task in which participants are expected to automatically encode an ending before they complete a subsequent recognition test in which they rate the similarity of four sentences in meaning to the original text (one

positive interpretation, one negative interpretation, and positive and negative foils to control for valence) (see Hughes, Gordon, Chalder, Hirsch & Moss-Morris, 2016, for review of methodological considerations). Each of these interpretation bias tasks seeks to identify a tendency to resolve ambiguity with negative, illness related or threatening interpretations. To date research investigating interpretational biases has also focused on chronic conditions, including chronic pain and chronic fatigue syndrome. There is reliable evidence of interpretational bias in pain conditions (e.g. Heathcote, Jacobs, Eccleston, Fox & Lau, 2017; Pincus and Morley, 2001; Schoth & Liossi, 2016) and in chronic fatigue syndrome (Hughes et al., 2017).

The investigation of implicit bias in illness is a relatively young field, and a number of methodological considerations might have impacted upon findings to date. Although it might be anticipated that chronic conditions are frequently accompanied by comorbid anxiety or depression and that this might impact upon findings, (e.g., Polsky et al., 2005), where cognitive biases have been observed in research to date, researchers have typically shown that extent of bias is unrelated to indices of affective disorder. While it is clear that stimuli must be specific to the concerns of the particular patient population under consideration, it is not clear what the content of those stimuli ought to be. For example, whilst investigation of fear of spiders might appropriately explore attentional biases towards spider stimuli, in the illness context stimuli might encompass situational cues that provoke symptom expectations (such as a verbal or pictorial depiction of a back-stressing movement) or symptoms representative of illness itself (such as fatigue or pain). If the goal is to determine bias in the interpretation of somatic experience as illness, consideration might also be given to presentation of stimuli in the somatosensory modality (e.g. van Laarhoven et al., 2017). Additional considerations concern the need for sample sizes that are adequate to detect differences in populations where response variability is necessarily likely to be great. We

would contend that consideration should also be given to the current goals of the samples. For example, patients in treatment or 'trying', even unconsciously (Aarts, 2007), to avoid attending to stimuli are likely to respond differently to those patients not in treatment (see also Field et al., 2016; Papies, Stroebe & Aarts, 2008).

Whilst evidence is suggestive of links between automatic cognitive processing and illness behaviour, the key premise of this research endeavor is that cognitive biases in attention and interpretation might be modifiable with consequential amelioration of experienced symptoms and therefore illness self-regulation. Research designs that establish if changes in cognitive bias are associated with, for example, reductions in fatigue or experienced pain or hyper-sensitivity to cancer recurrence might establish a causal role for cognitive bias and offer potential for psychological treatments. Cognitive Bias Modification, in which participants are trained to disengage from stimuli using a modification of the visual probe task (MacCleod et al., 2002) has evolved into various subtypes targeting attention bias, interpretation bias, and approach-avoidance training (e.g. Menne-Lothman et al., 2014), and some research is beginning to explore their utility in physical conditions such as pain (Sharpe et al., 2012; Heathcote et al., 2018). Distraction techniques have also been employed to address attentional bias in pain (e.g. van Ryckegen, van Damme, Eccelston & Crombez, 2018). To date there is limited evidence that these methods are effective in clinical samples and several studies report no significant or clinically relevant effect.

Research focus to date on participant samples with chronic disabling conditions obscures important ways in which implicit processes might be explored in the important everyday processes of detecting and identifying illness in the self. Williams, Wasserman, and Lotto (2003) and Henderson et al. (2007) investigated implicit illness schema using priming techniques. Priming refers to the activation of relevant mental representations by external stimuli (Bargh & Chartrand, 2000). Williams et al. (2003) showed that priming participants

by asking them to write about their last illness episode led participants with low self-rated health to respond more slowly to illness related words relative to controls in a subsequent Stroop task. Henderson et al. (2007) proposed that if information about illness is schematically organized, and a prime activates related memory content, then priming a specific illness should activate information associated with the primed illness, but not concepts associated with a different illness. Results of two experiments lend support to this suggestion. Participants primed with 'common cold' showed greater attention bias than controls to concepts associated with the common cold in a subsequent Stroop task, but not to words associated with cardiovascular disease. A second experiment demonstrated a reversal of this effect in that a cardiovascular disease prime led participants to respond more slowly to words associated with cardiovascular disease but not to words associated with the common cold. Findings not only point to schematic organization of well-known illness related information, but also suggest ways in which environmental primes might activate or prioritize particular schema. Viewed from this perspective, observations that healthy subjects who expect (are primed) to anticipate pain show greater attention to pain stimuli (Crombez et al., 2013) are consistent with activation of a pain schema.

Biases in attending to and interpreting somatic sensations as indicative of pathology might be associated with chronic activation of illness schema characterised by high threat, chronicity and uncontrollability. In essence, the prototype of the normal self in a chronically ill patient may become enmeshed in the illness prototype so that every sensory experience is attended to and interpreted as a symptom indicative of existing illness. Orbell and Henderson (2016) suggest that illness schema activation by priming might be viewed within an active self- account (Smeesters, Wheeler & Kay, 2010; Wheeler, DeMarree & Petty, 2007). People possess a vast chronic self-concept of which only a subset can be active at any given moment, and serves to guide behaviour (Markus & Wurf, 1987). If a prime (or somatic stimulus)

activates knowledge of the functionally deviant self (Leventhal et al., 2011) priming an illness schema might lead people to manifest behaviour consistent with the content of that primed illness. Orbell and Henderson provide evidence suggestive of this possibility, in that non-clinical, healthy participants exposed to subliminal cold/flu primes walked more slowly and performed more poorly on subsequent cognitive tasks.

A few studies have directly investigated the implicit self-concept in chronic illness. For example, Riebel, Egloff, and Witthoft (2013) present evidence of an implicit illness self-concept amongst people with somatoform disorders compared to controls using an Implicit Association Task (IAT: Greenwald, Nosek, & Banaji, 2003) that measured the strength of association between target words 'self' and 'other' and the attributes 'healthiness' vs 'discomfort'. IAT scores were also associated with somatic symptom reporting after covarying depression, anxiety, and negative affect, suggestive of an automatic attentional process that may foster negative interpretations of somatosensory stimuli. In a subsequent study, Riebel and colleagues (Riebel, Egloff, & Witthoft, 2014) report a pre-post trial of an intervention that used an evaluative conditioning task in patients with somatoform disorders. Following a baseline IAT in which participants sorted nouns reflecting either 'healthiness' or 'discomfort' into the categories 'self' or 'other', participants then completed an evaluative conditioning task (Baccus, Baldwin & Packer, 2004) in which they were trained to associate self-referential pronouns with health concepts. Results indicated that change in the implicit self-concept engendered by the conditioning task was associated with statistically and clinically significant reduction in symptoms and illness behaviour at 13-day follow up.

Future Directions

Chronic illness conditions such as those that have been the focus of research efforts to date, particularly those characterised under the umbrella term 'medically undiagnosed syndromes (MUS)' represent a major challenge for health psychology. It has been estimated

that up to three quarters of symptoms reported in primary care are not attributable to identified organic disease and about 25% of general practice patients have clinically relevant MUS, representing considerable economic burden and lost work (Fink, Toft, Hansen, Ornbol, & Olesen, 2007; Bermingham, Cohen, Hague, Parsonage, 2010). Patients with these conditions often embark upon a lengthy pursuit of organic causation via different medical specialisms. One recent model (Van den Bergh, Witthöft, Peterson & Brown, 2017) calls for a reconceptualization of medically undiagnosed syndromes as one extreme end of a spectrum in which the well-established lack of correspondence between organic pathology and symptom experience is recognised for all physical health conditions including those that are medically diagnosed. For example, subjective symptom reports correlate poorly with blood glucose levels in patients with diabetes (Frankum & Ogden, 2005); in heart disease, self-reported symptoms correlate poorly with objective parameters of disease (e.g. Sears et al., 2005). This conceptualization suggests that the brain automatically interprets sensory experience as benign versus symptomatic of illness according to predictions based on past experience. These predictions may sometimes result in inappropriate categorization of sensory experience. For example, the consciously and very really experienced 'symptom' of movement can be felt in an illusory manner when seated on a stationary train and observing a neighbouring train depart. Context cues and past experience will play a fundamental role in whether the brain interprets somatic experience as a symptom and whether that consciously felt symptom is interpreted as benign (a normal variation of the usual self) or threatening (represented in the CS-SRM as an activated illness schema). In the case of chronic illness, particularly that of long duration, errors in symptom detection by the interpretation of sensory experience might arise when sensory experience more normally 'fits' the illness prototype (me as ill) than an idealised and historic normal healthy self-prototype. For example, an individual who developed chronic fatigue syndrome at age 40 and has been ill for ten years

might fail to distinguish the normal somatic sensations that are typical of a person aged 50 years, from illness.

We would contend that viewing symptom experience and activation of one prototype versus another as a function of contextual cues, prior experience, and prototypes of the 'normal functional self' might provide valuable new insight into symptom detection and interpretation more generally. The CS-SRM anticipates the importance of past experience and context in these processes, but they have not been extensively studied to date. The implications are non-trivial and may impact in important ways upon the chances of injury, delay in seeking treatment, and inappropriate self-regulation attempts, as well as upon the behaviour of health professionals. Illness schema activation follows from deviations of the prototype of the typical normally functioning self, and these normal-self prototypes likely change with ageing as depicted in Figure 1. For example, Bernardes, Marques, and Matos (2015) showed that older adults (mean age 74 years) primed with a negative ageing stereotype were slower to report pain (had higher pain thresholds) in a cold presser task than participants exposed to either a positive ageing prime or a neutral prime. Importantly, the positive ageing prime served to attenuate the impact of an explicitly expressed negative ageing stereotype on pain detection. Findings point to a non-consciously mediated mechanism whereby accessibility of the active self-concept impacts upon symptom detection. One wonders how ageing self-conception might relate to identification of hearing loss or detection of early signs of dementia. Relatedly, idealised normative healthy self-protoypes may increase symptom detection and interpretation as illness during recovery postpartum, or after surgery (e.g. Howell et al. 2012, cf. Leventhal, Phillips & Burns, 2016b; Orbell et al., 1998).

Environmental context is also likely to impact upon illness identification in important ways. Orbell, Henderson, and Hagger (2015) showed that priming the common cold rendered

concepts related to the cold more accessible when the common cold was ‘in season’. If exposure to illness primes in the environment increases accessibility of a particular illness *identity*, people are more likely to rapidly detect, label, and act to manage symptoms they experience. In the context of a rising flu or meningitis pandemic, media communications might render schema for those conditions more accessible so that a headache (symptom) more readily activates a schema for, say, meningitis, rather than a benign condition. This might facilitate public health management of spread of the illness or treatment, if available (e.g. Bish & Michie, 2010; Leung, Ho, Chan, Wong & Hedley, 2003). Increased accessibility of a particular schema may also increase self- or professional misdiagnosis of symptoms with similar characteristics to the accessible illness (Leventhal, Leventhal & Breland, 2011) or lead the ‘worried well’ to match minor somatic deviations to the accessible schema (Cameron, Leventhal & Leventhal, 1995; Howren & Suls, 2011) and conclude that they are ill. Cognitive biases, such as those studied in the fields of decision making and cognitive illusion (e.g. Pohl, 2012) that are also proposed to operate without conscious intent and without the decision maker realising what has happened, have been studied extensively in health professionals. For example, a recent review (Saposnik, Redelmeier, Ruff & Tobler, 2016) concluded that the overconfidence effect, anchoring effect, information and availability biases may be associated with diagnostic inaccuracy or suboptimal patient management.

Little is known about the acquisition of illness knowledge and development of illness schema. Public health measures sometimes aim to form associations between relevant stimuli and illness labels (such as a recent UK campaign linking ‘coughing for more than 3 weeks’ to the label ‘lung cancer’). In clinical settings, failure to identify symptoms as indicative of acute disease progression suggests that symptoms have not been incorporated into disease schema so that threat activation is delayed. For example, congestive heart failure patients often fail to recognize fluid in the legs and lungs as indicative of progressed and acute heart

failure and therefore do not act to seek required emergency care. Relatedly, Leventhal, Diefenbach & Leventhal (1992) discussed cognitive biases that arise from faulty acute model 'if symptoms, then ill' thinking in patients with typically asymptomatic chronic conditions. These contexts may be considered as those in which an illness representation is not activated (between symptom episodes) with consequent failure to engage in prophylactic self-management.

Automatic Processes in Individuals' Illness-Threat Coping Response and Management

The self-regulation processes initiated by recognition of threat may encompass a broad range of coping responses that will differ according to whether the threat is acute or chronic, life threatening or relatively benign, and whether self-regulatory (coping) responses are short term or single actions vs. requiring longer term behavioural change. We contend that cognitive processes that operate outside of conscious awareness may influence coping behaviours in each of these contexts. To date, investigation of coping responses has tended to utilize global measures of coping style rather than investigate specific behavioural responses, and recent calls have been made for greater research focus upon measurable coping behaviours, such as medical consultations, medication use, diet, smoking and alcohol use changes, or engagement in treatment (Hagger et al., 2017). The following sections consider ways in which research might be extended to consider cognitive *accessibility* of, *implicit affect* toward, and *automatization* of coping behaviours for predicting behavioural engagement; we also suggest avenues for modification of coping responses. The roles of these processes are depicted in the right hand portion of Figure 1.

Cognitive Accessibility of Coping Responses

Illness prototypes are functional in that they serve to prompt conscious and non-conscious action (including non-medical responses, care-seeking, and existing treatments) to ameliorate threat and/or to restore the normal functioning self. For example, Leventhal,

Leventhal, and Contrada (1998) suggested: “The representation of an illness can affect behaviour only when it is activated, though activation does not imply that the representation will be fully conscious” (p.8). Some of these non-consciously mediated processes are behavioural correlates of biological responses to illness threat (e.g. such as resting or sleeping in association with immune function activity in response to infection, Orbell & Henderson, 2016; or immediate cessation of exertion in response to a pulled muscle during physical activity). To illustrate, consider that parents and carers recognise a state of ill health in a young child (or even a pet animal) by observation of change in a child’s normal activity and temperament rather than a verbal declaration of symptoms or illness labels. Such behavioural changes consistent with illness are likely preconscious, governed by brain systems that detect and interpret somatosensory deviation, and not accompanied by activation of a developed cognitive schema in a young child. Instead, parental observations likely activate illness schema leading to action taken with respect to the child.

Co-activation of illness schema stored in memory with associated coping responses has been investigated in two experimental studies. Henderson, Orbell, and Hagger (2009) theorized that if an individual had repeatedly used a particular coping strategy in a particular illness context, it was likely that the coping strategy would have become encoded in the illness schema as a consequence of frequent co-activation. Consistent with this hypothesis, findings of two experiments showed that subliminal activation of a cold/flu schema by subliminal priming resulted in attention to the coping strategies ‘lozenge’ and ‘lemsip’ in a subsequent grammatical decision task amongst frequent users. Ahluwalia, Hughes, McCracken, and Chilcot (2017) replicated and extended this finding by showing that a ‘headache’ prime influenced responses to the word ‘paracetamol’ amongst participants who had previously declared positive beliefs about the efficacy of paracetamol in the treatment of headache. An important observation in both studies is that heightened responsiveness to

coping responses did not occur as a direct consequence of past use, but only when the illness schema was also made accessible by priming. Findings show that behavioural tendencies associated with illness experiences in the past are encoded as part of the illness schema and are activated when that illness schema is subsequently activated—perhaps becoming the 'default' actions that are activated along with other information about illness. These processes are depicted by the bidirectional arrows between coping and automatic activation of coping responses in Figure 1. The implications of these findings are far ranging and may impact upon perpetuation of maladaptive as well as adaptive coping. For example, a patient who begins the use of a maladaptive coping strategy in response to a symptom that activates an illness schema might come to repeatedly use this strategy in a relatively automatic manner. Conversely, evidence that coping strategy activation requires illness schema activation provide insight into observations that patients with asymptomatic conditions such as hypertension, hayfever or asthma tend to adhere to treatment regimens and take prophylactic medications only when symptoms are present, ("I have asthma only when I have symptoms"; Halm, Mora, & Leventhal, 2006; Meyer, Leventhal, & Gutmann, 1985). Priming and context effects may also be relevant to promotion of positive management of diseases such as hayfever or asthma, where prophylactic medication use is recommended. Orbell et al. (2015) showed that even if an individual is not experiencing symptoms and 'seasonality' is low, priming might activate illness schema in the absence of symptoms and impact upon the timely use of preventive medications. Interventions that alter the perceived environment might therefore promote illness schema activation and preventive medication use.

To date, research has not addressed mechanisms for creating associations between illness schemas and coping actions. However, Lowe and Norman (2017) used data simulations to demonstrate that activation of parts of an illness representation (e.g., illness identity of heart attack) *automatically* activates an appropriate, coherent "profile" or *schema*

of beliefs (e.g., consequences as serious, timeline as acute/fast), which in turn automatically activates a previously trained/associated coping response (e.g., seeking emergency care). They therefore suggest that automatic processes can explain individuals' inappropriate as well as appropriate responses to illness threat signs, depending on their experiences and trained cognitive associations. One way in which stimuli may be made more accessible in memory and non-consciously activate particular coping actions is by forming implementation intentions (Gollwitzer, 1999). We address this possibility in a later section.

A few studies have shown associations between cognitive bias for illness relevant stimuli and behaviour. Hughes et al. (2017) reported positive correlations between somatic interpretive bias and 'all or nothing' coping behaviour in patients with chronic fatigue syndrome. Overdoing things when symptom free and needing to rest for prolonged periods in response to symptoms contributes to maintenance of fatigue. Jessop et al. (2004) showed that attentional bias in an asthma symptom Stroop task was associated with asthma preventative inhaler use in a U-shaped manner—that is, low adherers and high adherers both showed greater attentional bias to symptoms than moderate adherers. However, to date, changes in cognitive bias have not been shown to causally determine changes in coping behaviour.

Implicit Affective Evaluations of Coping Behaviours

Coping responses may be determined by their mental accessibility but also by individuals' implicit attitudes about and/or implicit affective responses to those actions—both towards health-promoting actions and existing, health-risky actions. Implicit attitudes are thought to be automatic affective evaluations of objects or behaviours that have been learned through past experience (Gawronski & Bodenhausen, 2006), and there is evidence that they may even form indirectly—that is, Payne, Lee, Giletta, and Prinstein (2016) showed that implicit positive attitudes towards drinking alcohol can develop during adolescence in advance of drinking alcohol. When relevant stimuli are encountered, affective associations

are rapidly and automatically activated. Implicit attitudes are important to measure, because individuals may possess implicit attitudes that cannot be captured by explicit (self-report questionnaire) methods; people may have social desirability concerns that make them unwilling to report attitudes, be unaware of their implicit attitudes and therefore unable to report them, or their reflective attitudes and opinions may be different to the more impulsive in-the-moment attitudes captured by implicit measures (Nosek, Hawkins, & Frazier, 2011).

Implicit attitudes may play a role in explaining attendance at medical consultations or attendance for medical procedures as well as medication use, and recommendations regarding behavioural change. This might be expected particularly to be the case where an explicitly held belief that a coping response is 'a good thing' coexists with an implicit negative affective reaction to the coping response and/or an implicit positive affective reaction to alternative/conflicting responses, such as might be held towards unpleasant but necessary aversive medical procedures or products (e.g., vile tasting yet nutritive tonics for individuals' at risk of malnutrition) or overcoming highly rewarding existing behaviours (e.g., high-fat snacks; substance use). Considering implicit attitudes/affect towards treatment-related behaviours may be also particularly important for illness domains that are highly sensitive or stigmatized and for which treatments may have negative associations, such as HIV, drug and alcohol abuse, pregnancy termination, mental illness, and diagnosis of dementia or hearing loss. Evidence suggests that implicit and explicit attitudes have discriminant validity and predict behaviour independently from each other (Greenwald, Poehlman, Ulman, & Banaji, 2009; Conner, Perugini, O'Gorman, Ayres, & Prestwich, 2007); therefore taking both into consideration may best advance understanding of individuals' engagement in specific coping responses.

Implicit attitudes towards health-related behaviours have been most commonly measured with reaction-time tasks, such as the IAT (Greenwald, McPhee & Schwartz, 1998),

and the evaluative priming task (Fazio, Sanbonmatsu, Powell & Kardes, 1986; Herring et al., 2013). In the evaluative priming task, participants are primed with health or treatment-related stimuli (e.g., words related to exercise or a person engaging in exercise) and then asked to judge a target word as positive or negative in valence. If the individual has a positive implicit attitude towards the stimulus, it is assumed he/she will more quickly judge a positive target word as positive and more slowly judge a negative target word as negative after being primed with the stimulus (speed is compared to that individual's speed in judging target words' valence after being primed with neutral stimuli). A method used to measure implicit attitudes particularly regarding substance use and that is not based on reaction time/latency is the affect misattribution procedure (AMP; Payne, Cheng, Govorun, & Steward, 2005; Payne et al., 2016). In this task, participants are primed with an image or word of interest (e.g., health- and treatment-related stimuli) and then asked to judge how pleasing a neutral stimulus, such as a Chinese pictograph, is. Implicit attitudes are inferred from the degree to which an individual finds the neutral stimulus to be more or less pleasing than similar images presented without a prime.

Some research has utilized implicit measures of medication-related attitudes, but the few studies to-date show mixed effects of implicit attitudes on adherence. Rüsch, Todd, Bodenhausen, Weiden, and Corrigan (2010) found that implicit attitudes towards psychiatric medications predicted perceived need for treatment among patients with psychiatric conditions but did not predict their adherence. Linn, Wennekers, Vervloet, van Dijk, & van den Bemt (2016) examined implicit attitudes towards rheumatoid arthritis medication. Explicit and implicit attitudes were unrelated in their study, and explicit attitudes predicted (self-reported) adherence whereas implicit attitudes did not. Goubert, Crombez, Hermans and Vanderstraeten (2003) employed an evaluative priming paradigm to demonstrate implicit negative affective responses to photographic representations of back stressing activity among

chronic pain patients compared to non-pain samples. Howell, Ratliff, and Shepperd (2016) developed a speeded (automatic) measure of attitude towards receiving health risk information regarding melanoma, heart disease or a fictitious illness that offered superior prediction of health information avoidance compared to an explicit measure.

Regarding lifestyle behaviours, there is some evidence that negative implicit attitudes towards physical activity are associated with lower levels of physical activity among obese individuals (Chevance, Caudroit, Romain, & Boiché, 2017) and in clinical populations requiring physical activity as treatment (Chevance, Varray, and Boiche, 2017). Antoniewicz and Brand (2016) used a reaction-time-based evaluative priming task to measure automatic affective evaluations of exercise and found that these evaluations predicted who dropped out early, who dropped out late, and who maintained exercise over the course of a 14-weeks programme. Positive implicit attitude towards unhealthy foods and alcohol is associated with greater consumption of those foods/alcohol (Friese, Hofmann, & Wänke, 2008; Hofmann, Rauch, & Gawronksi, 2007) in non-clinical populations. Children who are obese have shown an implicit positive attitude towards foods in general, compared to non-obese children but no difference in implicit attitude towards physical activity (Craeynest et al., 2005). Roefs and Jansen (2002) found that obese individuals had stronger *negative* implicit attitudes towards high fat foods than did non-obese individuals, however. There is very little evidence regarding the role of implicit attitudes towards unhealthy behaviours in clinical populations who are recommended to engage in lifestyle change for illness self-management.

There is some evidence that implicit attitudes can be modified using techniques such as evaluative conditioning (Hofmann, De Houwer, Perugini, Baeyens & Crombez, 2010). Evaluative conditioning trains participants to form new affective associations towards target stimuli by pairing them with positive and negative unconditioned stimuli. Evaluative conditioning has been found to improve individuals' automatic evaluations of exercise and

actual engagement in exercise (Antoniewicz & Brand, 2016) as well as altering affective responses towards and therefore impulses to consume unhealthy foods (Hollands, Prestwich, & Marteau, 2011; see also St. Quinton & Brunton, 2017). Hollands et al. (2011) paired images of unhealthy snacks with aversive consequences from eating those snacks (the evaluative conditioning) in order to alter individuals' implicit attitudes towards the snacks and promote healthier snack choices. Bui and Fazio (2016) used evaluative conditioning to train associations of healthful and unhealthful foods. Results showed that training increased sensitivity to health and decreased sensitivity to taste. This research suggests possible avenues to intervention directed at altering patients' implicit attitudes towards treatments.

Chevance et al. (2017) report an interesting study of patients with pulmonary respiratory disease undergoing rehabilitation. Such patients are encouraged to be physically active yet often find physical activity aversive and fear unpleasant sensations. The authors measured implicit attitudes using an IAT measure with the target concepts 'physical activity' and 'sedentary'. During rehabilitation, patients took part in supervised sessions of gym type physical activity. Implicit attitudes towards physical exercise changed significantly during rehabilitation, whereas explicit attitudes towards exercise did not. Moreover, implicit attitudes measured at the completion of rehabilitation predicted physical activity 6 months later. This study underscores the importance of implicit evaluations in illness contexts. The rehabilitation program was not specifically designed to modify implicit evaluations, indicating that practicing physical activity *itself* modified implicit attitudes. Positive experience of, or perhaps mere exposure to the attitude object (physical activity), directly conditioned an implicit evaluative attitude.

The upper right portion of Figure 1 depicts the potentially bi-directional relationship between implicit attitude and coping behaviour, such that implicit attitudes might impact upon initiation and maintenance of coping behaviours, and coping behaviours might as a

consequence of conditioning over time, become associated with more positive implicit attitudes.

Future Directions. Further research using implicit attitude measures is warranted, and should where possible employ objective outcome measures. Interventions that seek to modify patients' implicit attitudes towards treatment may prove useful. These methods may also provide insight into relations between patients and health professionals, for example patients' mistrust (negative affect) towards doctors, that may impact upon appropriate care-seeking. Implicit affect has been shown to predict detection or acknowledgment of pain in patients by non-health professional participants (De Ruddere et al., 2011). Following an associative conditioning task in which participants were trained to like or dislike photographic images by pairing them with positive or negative personal attributes, participants watched video clips of the same people engaging in pain inducing activities and were asked to rate their pain. Findings showed that observers' perceptions of pain were moderated by likeability, such that they were less likely to endorse the belief that a patient was in severe pain if they had developed negative patient evaluations. Relatedly, Kaseweter, Drwecki and Prkachin (2012) report racial bias in pain empathy and treatment recommendations suggesting that implicit negative affective stereotypes might be important in explaining documented discrepancies in treatment that may extend to older people and other negatively stereotyped groups. The observation of symptoms in other people is important to symptom management and these studies delineate implicit affective mechanisms that might impact upon the professional behaviour of carers, nurses, and physicians.

Although their effect on automatic affective associations with treatment behaviours have not been studied, implementation intentions have been shown to alter emotional responses (disgust and fear) to stimuli (Gallo, Keil, McCulloch, Rockstroh, & Gollwitzer,

2009). Relatedly, impulsive defensive reactions to health threat information may be modified by self-affirmation techniques (e.g. Kessels, Harris, Ruiter & Klein, 2016).

A further interesting line of enquiry concerns the use of advertising to condition positive evaluations of self-remedies or prescribed medications in those few countries (USA and New Zealand) that permit direct to consumer advertising of prescribed medications. Just as product labeling and images might impact upon healthful misinterpretations of food products (e.g. Klepacz, Nash, Egan, Hodgkins & Raats, 2016), so pharmaceutical advertising might capitalize on viewers passive goal for curative remedies by increasing their implicit affect for particular drugs and influencing requests made to physicians (e.g. Biegler, 2015).

Strategic Automatization of Coping Behaviours

In addition to influencing the cognitive accessibility of coping responses and evaluative orientation towards a particular coping response, automatic processes may govern or be leveraged to influence individuals' likelihood to (1) adopt new, goal-directed (i.e. treatment, health) behaviours and/or successfully navigate medical procedures, (2) maintain goal-directed behaviours over time (i.e. adherence), and (3) change existing, health-risky behaviours. Promoting these behaviours is of considerable importance for healthcare, given evidence that patients often delay seeking necessary care, fail to complete treatments, miss medical appointments, and do not adhere to medication or other self-management behaviours (e.g. Kravitz & Melnikow, 2004; Orbell, Hagger, Brown, & Tidy, 2006; Van Dulmen et al., 2007).

A key element of the CS-SRM shown to promote behaviours in all three of these domains, is *action planning.* Action planning refers to a process of consciously considering and deciding upon actions to take in the pursuit of a goal and typically involves mentally pairing expected environmental cues with intended actions (see Hagger & Luszczynska, 2014 for a conceptual review). For example, individuals may form implementation intentions or "if

[cue], then [action]" plans that link cues to an intended action (Gollwitzer, 1999). The CS-SRM additionally sees action planning as a process of "preparing the perceptual system" for upcoming medical procedures or, theoretically, for rapid detection of symptoms associated with disease or treatment progression (e.g., symptoms that treatment is not working as cues for seeking follow-up care). An important element/process of action planning is a visualization of the future context in which action should occur. The planned "cues" for behaviour may be environmental/situational cues meant to trigger a desired action (e.g. 'Immediately after I have eaten my breakfast, then I will take my medication"). They may also be somatic "cues" or sequences of somatic experiences associated with a medical procedure, illness, or treatment (e.g. "If my legs are swollen, then I will go to the emergency room"). Although action planning is a purposeful (i.e. conscious and reflective) process, evidence suggests that it functions to promote these behavioural outcomes via automatic mechanisms. Planning may also have particularly powerful benefits for populations with poor prospective memory (Wolff, Warner, Ziegelmann, Wurm, & Kliegel, 2016), such as older patients (Zogg, Woods, Sauceda, Wiebe, & Simoni, 2012), who are much more likely to have chronic illness than younger individuals.

Promoting treatment initiation. Research regarding treatment initiation has largely focused on reflective factors, such as explicit beliefs and behavioural intentions (Hagger et al., 2017). However, reflective factors, such as behavioural intentions are notoriously weakly related to behaviour, a phenomenon referred to as the "intention-behaviour gap" (Orbell & Sheeran, 1998; Orbell, 2004; Inauen et al., 2016). Individuals' engagement in action planning and a process called coping planning (Schwarzer, 2008) which concerns specifying plans to overcoming anticipated barriers to action improves the translation of intention into action.

Planning promotes behaviour enactment through multiple automatic mechanisms. First, identifying and rehearsing a behavioural context cue makes that cue more accessible in

memory and ensures that the cue is detected when it is encountered. Second, by forming a strong link in memory between cue and action, the cue acquires the ability to automatically elicit action. That is, planning with mental rehearsal fosters implicit goal activation (Sheeran et al., 2013), or the automatic activation of cognitive schemas associated with goal pursuit in the presence of associated cues (Papies & Hamstra, 2010; Papies, Stroebe & Aarts, 2008). Evidence for the strategic automatization engendered by planning comes from research in laboratory settings, where the researcher can determine the action cue for all participants and collect response-time measures to gauge mental accessibility of those trained/planned cues. For example, Aarts, Dijksterhuis, & Midden (1999) had individuals plan to collect a coupon in a location with salient external cues (e.g., a fire hose) and then measured the mental accessibility of cues in the individuals' minds with a lexical decision task with these cues as stimuli. Participants in the planning condition responded faster to these cues than participants in the control condition, and response latency mediated the effect of the intervention on behavioural enactment (obtaining the coupon).

A host of studies have investigated the role of planning in enhancing the likelihood of enacting behaviours, including breast and testicular self-examination (Orbell, Hodgkins & Sheeran, 1997; Prestwich et al., 2005; Benyamini, Ashery, & Shiloh, 2011; Heverin & Byrne, 2011), health screening (Neter, Stein, Barnett-Griness, Rennert, & Hagoel, 2014; Rutter, Steadman, Quine, & Field, 2006; Sheeran & Orbell, 2000), medication and supplement adherence (Sheeran & Orbell, 1999; Liu & Park, 2004; Jackson et al, 2006; Brown, Sheeran, & Reuber, 2009; Chatzisarantis, Hagger, & Wang, 2010; O'Carroll, Chambers, Dennis, Sudlow, & Johnston, 2014; Brom et al., 2014), diet (Adriaanse, Gollwitzer, de Ridder, de Wit, & Kroese, 2011), and exercise (Belanger-Gravel, Godin, Bilodeau, & Poirier, 2013; Carraro & Gaudreau, 2013; Milne, Orbell & Sheeran, 2002). However, few studies to date have investigated their use in clinical samples or employed planning to teach patients how to

prepare for and respond to unpleasant medical procedures. Farmer and colleagues (2016) tested a brief planning intervention as a sub-study of a clinical trial for a new medication for Type 2 diabetes. Patients in the intervention group were prompted at the beginning of the trial to formulate action plans to take the study medication regularly (they were asked two questions: “When do you plan to take your study medication” and “Where do you plan to take your study medication”) and were reminded by nurses to use their action plans during the trial. These intervention participants did not show any difference in adherence compared to control participants, who followed the standard trial protocol. Likewise, Lourenco and colleagues (2014) found no effect on medication adherence of an action planning (i.e. plans to enact treatment behaviour) plus coping planning (i.e. plans to overcome barriers) intervention compared to control condition in a sample of patients with coronary artery disease. The intervention prompted participants to write up to three action plans regarding when, where, and how they intended to take their medication; and to identify up to three barriers and one to two strategies for overcoming these barriers to taking their medication. The lack of benefit from the basic planning interventions reported by Farmer et al. (2016) and Lorenco et al., (2014) may be attributable to lack of commitment to, or mental rehearsal of the plans, since participants were only asked to answer questions about plans and not to rehearse the planned cue-action pairings in mind. However, in a similar intervention (without rehearsal of plans) in a sample of patients presenting with knee pain to a physiotherapist, Hui, Hagger, Goh, Hart, and Gucciardi (2017) found that action-plus-coping planning resulted in significantly greater engagement in preventive therapy home-sessions compared to controls. Orbell and Sheeran (2000) found joint replacement patients who planned walking activity post surgery recovered more quickly. In a correlational study of patients with coronary heart disease, Sniehotta et al. (2005) found that self-reported action (e.g., “I have made a detailed plan regarding when to exercise”, completely disagree (=1) to totally agree (=4) and coping

plans (e.g. “I have made a detailed plan regarding what to do if something interferes with my plans”) predicted adherence to physical activity recommendations for cardiac rehabilitation post heart attack. Johnson and colleagues (Johnson & Leventhal, 1974; Johnson et al., 1973) found that patients who planned to swallow in response to a sensation during endoscopy experienced less stress during the procedure and required lower doses of tranquilizer—and these effects occurred for some without a conscious memory of the instruction session the night before.

Promoting longer-term behavioural maintenance/adherence. Recent literature has outlined automatic processes involved in longer-term treatment adherence (i.e. maintenance) within a CS-SRM framework (Phillips, Cohen, Burns, Abrams, & Renninger, 2016; Phillips, Leventhal, & Leventhal, 2013)—specifically the development of treatment-related habits. Briefly, once a patient has formed illness representations and decided upon a course of action, he/she forms treatment representations, may or may not engage in formal action planning, and attempts the treatment. With initial treatment attempts, patients may attain “mental model coherence” if they receive experiential feedback that the treatment is working as expected. Theoretically, if patients’ expectations for treatment outcome are met, their models will be coherent, and the treatment action is more likely to be repeated. If an unexpected and/or particularly aversive outcome occurs when treatment is attempted, the patient may re-formulate illness and treatment representations and be less likely to repeat the tested treatment. With coherence and continued repetition in the short-term (short term adherence), which may be entirely reflectively controlled, treatment-related actions can become habitual, *if repeated in the presence of stable contextual cues*. These processes are depicted in the upper right hand portion of Figure 1.

Habits are a specific form of cue-response association formed in memory as a consequence of repeated performance of a particular action in response to a particular cue

context (Wood & Rünger, 2016). Habits are distinctive from primed goals in that whereas a primed goal may elicit a range of different behaviours consistent with that goal, a habit links a context cue to a particular action. A mental representation is formed of the cue-response association. Although habits can originate from conscious goal directed behaviour as outlined above, once formed through repetition, strong habits become goal independent—that is, action will follow automatically whenever the cue is encountered, irrespective of current motivational state. For example, Neal, Wood, Wu and Kurlandi (2011) showed that people who possessed a strong habit to eat popcorn in the cinema ate similar quantities of popcorn, when in a cinema context (but not in an alternate context), whether the popcorn was fresh or stale. People with weak habits were guided by their motivation and ate less of the stale popcorn. Orbell and Verplanken (2010) showed that habit is associated with implicit attention to cues and strength of habit predicted the likelihood of smokers making action slips (such as lighting a cigarette) after smoking in public places became illegal and they were motivated to comply with the law. This attribute of habits, the ability to guide behaviour independently of motivation, has positive advantages in regard to desired habits. For example, habits will persist in the face of waning motivation, stress or distraction (e.g. Neal, Wood & Drolet, 2013). Rebar, Elavsky, Maher, Doerksen, and Conroy (2014) found that individuals with strong exercise habits were likely to exercise even on days when their intention to do so was low(er). Habits are resistant to changes in reflective factors, such as behavioural intentions or beliefs, do not tax cognitive and self-regulatory resources, and are the default behaviour. Therefore, theoretically, habitual treatment-related actions are more likely to be repeated in the future than non-habits, which are subject to changes in attitudes, goals, and mental resources (Hunt, Matarazzo, Weiss, & Gentry, 1979). Habits should therefore promote optimal *long-term* treatment adherence, or maintenance (Rothman, Sheeran, & Wood, 2009; Rothman et al., 2015) and optimize health outcomes, where habitual actions are appropriate.

Habits can be measured by examining response times in matching cue contexts to stimuli (e.g. Neal, Wood, Labrecque & Lally, 2012), by multiplying behavioural frequency and context stability (e.g., Wood, Tam, & Witt, 2005) or, more conveniently in clinical contexts or when it is desirable to assess strength of automaticity characteristic of a strong habit and changes over time as habits develop, by employing a self-report habit index (SRHI) which has been validated against implicit measures (Verplanken & Orbell, 2003; Orbell & Verplanken, 2010; Galla & Duckworth, 2015). The questionnaire requires respondents to respond to 12 items assessing the extent to which their action (e.g. taking medication) is automatic, non-deliberative (e.g. I start doing it before I realize I am doing it) and repetitive. The questionnaire is generic and can be adapted to any cue-response of interest by employing an appropriate stem that specifies the cue and the response (e.g. 'taking my medication immediately after eating my breakfast is….'). Patients might be asked to specify their own cues for the behaviour in question.

Evidence for the importance of treatment-related habits for treatment adherence comes from observational studies that measure patient-reported habit strength for engaging in their treatments (taking medications and engaging in physical activity). Bolman, Arwert, and Völlink (2011) found that adolescents' habit strength for taking their prophylactic asthma medication predicted adherence. Phillips et al. (2013) found that patients' reported habit strength for taking their hypertension medications predicted variance in objectively-measured adherence, incrementally to reflective variables (e.g., beliefs about medicines). Phillips et al. (2016) replicated these findings in a more complex illness/treatment domain (Type 2 diabetes) and for multiple treatment behaviours (taking medication and physical activity). Using more qualitative methodology, Brooks et al. (2015) found that specific routines characterize successful self-management of asthma, such as keeping one's asthma inhaler in the bathroom to facilitate the routine of using the inhaler when engaging in one's typical

morning hygiene routine. Evidence has also been found for the importance of habit in other behavioural domains. For example, Presseau et al. (2014) found that providers' reports of intentions and behavioural automaticity predicted their reported engagement in several patient care behaviours (providing weight advice; prescribing particular treatments). And, habit strength has been very widely studied in the domain of health-related behaviour in general (e.g., physical activity and dietary behaviours; Arnautovska, Fleig, O'Callaghan, & Hamilton, 2016; Gardner, de Bruin & Lally, 2011).

While patients may form habits spontaneously via behavioural repetition, this will not necessarily be the case if the behaviour (for example medication use) has not been repeatedly performed in exactly the same cue/context. Inconsistent or unreliable adherence may therefore be accounted for by lapses in memory or motivation. Encouraging patients to form habits may be beneficial in many clinical contexts. For example, developing an exercise routine such as walking daily, eating fruit daily, using prophylactic medications, or washing hands when changing dressings may all benefit from interventions to create habits. Effective development of habit requires attention to selection of appropriate cues, and consistent performance of the same act. The cue must be salient, and occur at the same frequency as the desired action. The cue, if a part of an existing behavioural routine, such as eating lunch, should ideally be identified at the *end* of the existing routine, or task boundary (after finishing bathroom routine, after finishing lunch, as soon as I return home), where behaviour is less likely to automatically run on to another element of an ongoing task and the opportunity be missed. Additionally, attention should be given to the action itself and to ensuring that people possess the necessary knowledge and skills to perform the action and any necessary equipment is kept visible and available (Wood & Rünger, 2016; Lally & Gardner, 2013) Habits do not form quickly, however (Lally, van Jaarsveld, Potts, & Wardle, 2010), and planning via implementation intentions may enhance the speed of habit development.

Evidence that action planning can lead to automatic engagement in behaviour comes from habit development interventions; for example, Judah, Gardner, and Aunger (2013) found that pairing flossing with an existing tooth-brushing habit (specifically, flossing after the cue of brushing) increased behavioural automaticity over the course of a month, and Orbell and Verplanken (2010) found that implementation intentions to floss in response to a specific situational cue resulted in significantly greater flossing habit strength compared to controls.

Overcoming existing, counter-intentional (health-compromising) habits.

Modifying unhealthy behaviours is an important endeavour, particularly since obesity and substance use have high prevalence in sick populations, and changing the course of serious illness often implies lifestyle change. The focus on automatic processes involved in unhealthy behaviours no doubt arises in part from dual process theorizing that pits healthful intentions against unhealthful implicit mechanisms—a dichotomy that has evidence from neuroscience, which shows habitual and goal-directed behaviours are controlled by different areas of the brain (see Dolan & Dayan; Wood & Rünger, 2016). The maintenance of undesired habits is not the consequence of a strong desire to continue the behaviour, although people may sometimes infer (and report) that their actions are motivated because ease of choice and action is confused with intentionality (‘I always do it so I must want to’). Because habits and goals are governed by different brain regions, merely developing an intention to change behaviour will not alter the factors that control action. In short, undesired habits are maintained by recurrent activation by the cues with which they are associated. Undoing habits represents a significant challenge for illness self-regulation.

Strategies for modifying these existing unhealthy behaviours should not rely on individuals’ intentions to do so, given the lack of importance of intentions when habits are strong (Aarts, 2007). Instead, changing habits will require individuals to be aware of the environmental cues (i.e., via conscious monitoring of one’s own behaviour in context) and to

take advantage of opportunities to change these cues and to establish new, healthy cue-behaviour associations. We exemplify possible approaches to changing existing habits, by modifying availability of the cue, or the response, or the cue-response association in memory.

First, one may take advantage of natural context changes in order to implement new, healthier habits (Wood, Tam, & Wit, 2005). For example, when one moves to another location (moves home), the individual can avoid old behavioural cues and set new cues for healthier behaviours in the new context/location—the context change not only removes the individual from existing cues but provides an opportunity for the individual to engage in motivated behaviour change (the "habit discontinuity hypothesis"; Verplanken, Walker, Davis, & Jurasek, 2008; Verplanken & Roy, 2016). Acute illness may similarly cause sufficient disruption in previous routines so as to provide a 'window of opportunity' to remove context cues from the home or provide an opportunity to create new health promoting habits, as previously described.

Two other approaches to overcoming unhealthy habits are outlined in a recent conceptual review by Papies (2016), who distinguishes between interventions that alter cues to unhealthy behaviours ("cueing interventions") and interventions that train new responses to existing cues ("training interventions"). Papies, Potjes, Keesman, Schwinghammer, and van Koningsbruggen (2014) found that a health prime reduced the number of unhealthy snacks purchased by overweight but not normal weight individuals (compared to overweight individuals in a control condition without a prime). Another cueing intervention method to change eating behaviour for the better is to alter portion sizes of foods, which can lead to more (healthy) or less (unhealthy) foods being eaten without individuals' awareness (Hollands et al., 2015). Evidence in populations with chronic illness engaging in lifestyle change efforts for illness self-regulation is lacking.

Employing implementation intentions to automate new cue-behaviour associations involves replacing an existing cue-response association in memory with an alternate response to the same cue. However, evidence to date shows the cue may activate both 'old' and new responses, leaving behavioural choice to the individual (Adriaanse et al., 2011) and necessitating effortful inhibition of response. Armitage (2016) recently provided evidence that implementation intentions may help smokers quit. In a non-clinical population, Adriaanse, de Ridder, and de Wit (2009) found that implementation intentions that specified a "motivational (why) cue" rather than a "situational (where/when) cue" were more successful at altering students' unhealthy snacking habits. Adriaanse, van Oosten, de Ridder, de Wit, and Evers (2011) found, however, that implementation intentions with a negating structure (i.e., "if [cue], then *not* [behaviour]" strengthened the existing cue-behaviour association.

Inhibitory control training seeks to help individuals overcome impulses to engage in health-risky behaviours by giving them repeated practice at self-regulation. Allom, Mullan, and Hagger (2016) conducted a meta-analysis of inhibitory control training methods and found that a go/no-go task resulted in the largest effects on health behaviour (specifically, eating and alcohol consumption behaviours). Other such intervention methods, which aim to alter the automatic behavioural responses to cues, include attentional bias modification and approach-avoidance training. For example, Wiers, Eberl, Rinck, Becker, and Lindenmeyer (2011) conducted cognitive-bias modification training using an avoidance-training task in which patients with alcoholism completed four sessions in which they were trained to push a joystick away ("avoidance movements") from alcohol images; compared to non-trained patients, trained patients showed more automatic avoidance of novel alcohol images in subsequent treatment sessions and had better treatment outcomes a year later. More research is needed in these promising areas of intervention into automatic illness processes, because

evidence for these techniques is primarily limited to young, healthy participants and laboratory studies with brief follow-up periods.

Future directions. Planning interventions that strategically automatize behaviour show considerable promise in preparing for medical procedures and in ensuring opportunities for treatment are not missed, and in establishing new adherence habits, for example. These may be particularly valuable in contexts where adherence is independent of current symptom experience. Interventions might usefully target both motivational factors (illness representations and treatment beliefs) and planning. For example, O'Carroll et al. (2014) report an intervention to increase adherence to antihypertensive medications among patients following stroke. The intervention addressed both reflective (patient beliefs) and automatic (habit formation via implementation intentions) processes, and increased adherence relative to controls (10% greater, measured electronically, over 3 months). Effects were explained by changes in beliefs (lower concerns about the treatment) and reduction in forgetting to take their medications. Unsurprisingly, the intervention was effective only for those who did not have pre-existing routines, emphasizing the need for baseline assessment of adherence and where possible, populations for whom a behaviour is novel, (inception/incident samples) (Hagger et a., 2017; Leventhal et al., 2016; Phillips et al., 2016). This study is a good example of how an intervention can target both automatic and reflective CS-SRM processes to improve adherence.

Further research might evaluate whether tying meaning to cues might facilitate automatic activation of schemas associated with better self-regulation of illness threats. For example, if patients are trained to identify a symptom as an indication of illness worsening, appropriate care-seeking protocols could be automatically activated. Research might also consider the types of cues, timing of cues, etc, that might optimize effectiveness of action planning interventions. Planning interventions in which patients make and rehearse plans for

actions in response to somatic experiences and or treatment actions in response to contextual cues may also affect implicit attitudes and reflective factors that could further improve intervention effectiveness, such as patient self-efficacy for managing the threat, attitudes regarding the importance of managing the threat, and concerns regarding the threat and its management.

It is important to recognize when routinization is and is not appropriate. Self-regulation of complex chronic illnesses likely require multiple treatment-related actions, some of which require a deliberative response and some that would benefit from being fully automatic so as to free cognitive resources for other tasks (and to avoid forgetting the treatment-action). For example, self-regulation of Diabetes often requires regular blood glucose monitoring, insulin administration, medication adherence, physical activity, and dietary restrictions/practices. Whereas some treatment behaviours may optimally be habitualized (e.g., medication-taking and physical activity; Phillips et al., 2016), others such as response to a blood glucose monitoring test (e.g., eating a snack, injecting insulin, taking a walk) depends entirely on the blood glucose reading and may therefore be a process optimally under deliberative control.

Interventions designed to promote optimal self-regulation of illness will likely include habit formation strategies, such as implementation intentions, action planning and coping planning, context changes, piggybacking on existing cues, situational reminders, etc. (see Rothman et al., 2015). However, the particular actions that might appropriately be habitualized, their interactions with other treatment-related actions, and for which patients still need to be determined. Additionally, given that weight loss, smoking cessation or reduction in alcohol use is “prescribed” for many chronic conditions and for preparation for surgery, inhibition of existing habits may need to be integrated into interventions that promote health-promoting habits.

Conclusions

Early accounts of the CS-SRM (e.g., Leventhal et al., 1980) anticipated a role for non-conscious processes in the important tasks of detecting, identifying and regulating illness in the self. Only recently have specific automatic processes been identified and methods developed to study them. We found evidence for a developing science addressing implicit processes in illness self-regulation and have addressed processes relating to illness-threat detection/recognition and interpretation, initiation of coping responses, treatment choice and action planning, and longer-term management of illness. The present article is the first to review how such processes are implicated in illness self-regulation and to outline an agenda for future research. The current review also extends recent literature on automatic processes and health, in that it is the first to take a broad view of health-related behaviour that includes but is not restricted to issues of preventive health behaviour or to investigation of a particular behaviour or illness. Health psychology can and should be equally concerned with processes of illness self-regulation.

Some have questioned whether it is appropriate, or even ethical to use methods that seek to direct behaviour by means of the unconscious. However Petrescu and colleagues (2016) report a study that assessed the acceptability of a range of public health interventions that were presented to randomized groups of participants in the US and UK as operating either by conscious or non conscious mechanisms and found no difference in acceptability according to described mechanism. Perceptions of efficacy of interventions drove judgements of acceptability. Research in this field requires of necessity consent of participants and debriefing procedures. People are continuously exposed to ‘marketing interventions’ that promote ill-health via mechanisms of which the recipient is unaware. Research and intervention in this field seeks to identify and address these influences and their

consequences, and to some extent, to leverage phenomena in the pursuit of promotion, restoration and maintenance of health.

We have organized and presented the evidence within a CS-SRM framework to illustrate how integration of methods and theory might enhance understanding of illness self-regulation. While the present review focuses upon aspects of non-conscious self-regulation, development in this field will likely require integration of these processes with conscious reflective self-regulatory processes and their dynamic interactions.

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Table 1.: Glossary of key concepts and methods discussed in the review.

Section of the review in which the terms are discussed	Terms	Definition/Description	Examples of references cited in the text (see text for additional references)
I. Automatic Processes in Individuals' Illness-Threat Detection and Interpretation	Explicit cognition	The explicit, cognitive products of cognitive processing, such as beliefs about one's illness and treatment that are often measured with self-report measures.	Hagger & Orbell, 2003; Hagger, Koch, Chatzisarantis & Orbell, 2017.
	Implicit cognition	The cognitions and processes that stay outside of a person's conscious awareness but nonetheless, when activated, may control thought and action even when an individual is unaware of this influence.	Aarts, 2007; Bargh, 1994
	Illness schema: Cognitive structure	The organization of information one holds about an object/behavior in memory (e.g., schematic knowledge about illness including associated symptoms, explicit beliefs about the illness cause, consequences etc., and appropriate actions/responses.	Henderson, Hagger & Orbell, 2007; Leventhal, Leventhal & Breland, 2011; Leventhal, Leventhal & Contrada, 1992; Leventhal, Phillips & Burns, 2016
	Attentional bias	A cognitive process in which particular stimuli (e.g. of a certain category, such as symptoms) capture a person's attention; that is, the person is biased to attend to these stimuli.	Crombez, Van Ryckeghem, Eccelston & Van Damme, 2013; Henderson, Hagger & Orbell, 2007; Hughes, Hirsch, Chadler & Moss-Morris, 2016; Hughes, Chadler, Hirsch & Moss-Morris, 2017; MacLeod, Matthews & Tata, 1986; Pincus & Morley, 2001; Stroop, 1935
	Interpretation bias	A cognitive process in which individuals resolve ambiguity and uncertainty in determining the meaning of an event/stimulus and selecting a	Heathcote, Jacobs, Eccleston, Fox & Lau, 2017; Hirsch, Meeten, Krahe & Reeder, 2016; Hughes, Chadler, Hirsch & Moss-Morris, 2017; Mathews & Mackintosh,

		response to the event/stimulus.	2000; Pincus & Morley, 2001; Schoth & Liossi, 2016
	Implicit normal somatic and functional self-concept	A schema that encompasses information about the self, stored in memory. The self-concept is vast and active subsets guide behaviour. The degree to which an individual's self concept deviates from an 'illness self-concept' may determine interpretations of symptoms as normal versus threatening.	Leventhal, Leventhal & Breland, 2011; Leventhal, Phillips & Burns, 2016b; Marcus & Wurf, 1987: Orbell & Henderson, 2016; Riebel, Egloff & Witthoft, 2014; Smeesters, Wheeler & Kay, 2010; Wheeler, De Marree & Petty, 2007
	Priming	The activation of relevant mental representations by external stimuli.	Aarts (2007); Bargh & Chartrand, 2000; Henderson, Hagger & Orbell, 2007; Orbell, Henderson & Hagger, 2015; Papies, 2016
	Cognitive Bias Modification	Procedures in which participants are trained to disengage from stimuli using a modified visual probe task.	MacLeod, Rutherford, Campbell, Ebsworthy & Holker, 2002; Sharpe, Ianiello, Dear, Perry, Refshauge & Nicholas, 2012; Heathcote, Jacobs, van Ryckejhen, Fisher, Eccleston, Fox & Lau, 2018
	Decision making biases	A field of research that explores the role of illusion and cognitive biases in decision-making. Biases include over-confidence, anchoring, availability heuristics etc.	Pohl, 2012; Saposnik, Redelmeier, Ruff & Tobler, 2016
II. Automatic Processes in Individuals' Illness-Threat Coping Response and Management			
A. Cognitive Accessibility of Coping Responses	Automatic coping responses	Behavioural tendencies that are associated with illness experiences in the past and are encoded as part of the	Henderson, Orbell & Hagger, 2009; Leventhal, Leventhal & Contrada, 1998; Lowe & Norman, 2017

		illness schema and activated when that illness schema is subsequently activated—perhaps becoming the 'default' actions that are activated along with other information about illness.	
B. Implicit Affective Evaluations of Coping Behaviours	Implicit attitudes	Automatic affective evaluations of objects or behaviours that have been learned through past experience and may develop indirectly (without direct personal experience of the object/behaviour).	Gawronski & Bodenhausen, 2006; Greenwald, McPhee & Schwartz, 1998
	Implicit Association Test (IAT)	A computerized test that presents participants with stimuli that represent two comparison categories (e.g., "self" vs "other") and measures the strength of association of these categories with target attributes ("healthy" vs "ill") via reaction time assessment (e.g., reaction time to "self" "healthy" word pairs compared to "self" "ill" word pairs).	Chevance, Caudroit, Romain & Boiche, 2017; Chevance, Varray & Boiche, 2017; Greenwald, McPhee & Schwartz, 1998; Grrenwald, Nosek & Banaji, 2003
	Evaluative Priming Task	A task in which participants are primed with health or treatment-related stimuli (e.g., "exercise") and then asked to judge a target word as positive or negative in valence. If the individual has a positive implicit attitude towards the stimulus, it is assumed he/she will more quickly judge a positive target word as positive and more slowly judge a negative target word as negative after being primed with the stimulus.	Fazio, Sanbonmatsu, Powell & Kardes, 1986; Herring, White, Jabeen, Hinojos, Terrazas, Reyes, Taylor & Crites, 2013

	Attention Misattribution Procedure (AMP)	A task in which participants are primed with an image or word of interest (e.g., health- and treatment-related stimuli) and then asked to judge how pleasing a neutral stimulus, such as a Chinese pictograph, is. Implicit attitudes are inferred from the degree to which an individual finds the neutral stimulus to be more or less pleasing than similar images presented without a prime.	Payne, Cheng, Goverun & Steward, 2005; Payne, Lee, Giletta & Prinstein, 2016.
	Evaluative (or associative) conditioning	A technique for modifying implicit attitudes that trains participants to form new affective associations towards target stimuli by pairing them with positive and negative unconditioned stimuli.	De Ruddere, Goubert, Prkachin, Stevens,Van Ryckeghem & Crombez, 2011; Hofmann, De Houwer, Perugini, Baeyens & Crombez, 2010; Hollands, Prestwich & Marteau, 2011; Riebel, Egloff & Witthoft, 2014
C. Strategic Automatization of Coping Behaviours	Action planning	A process of consciously considering and deciding upon actions to take in the pursuit of a goal, which typically involves mentally pairing expected cues (environmental or somatic) with intended actions. Also a process of associating meaning and appropriate responses with expected somatic experiences such as would occur during medical procedures. Certain types of planning such as implementation intentions can strategically automatize responses to cues.	Gollwitzer, 1999; Hagger & Luszczynska, 2014; Schwarzer, 2008
	Implementation Intentions	A specific type of action plan that explicates “if [cue], then [action]” links that lead to strategic automatization.	Gollwitzer, 1999; Hui, Hagger, Goh, Hart & Gucciardi, 2007; Neter, Stein, Barnett-Griness, Rennert & Hagoel, 2014;

			O'Carroll, Chambers, Dennis, Sudlow & Johnston, 2014; Orbell, Hodgkins & Sheeran, 1997; Orbell & Sheeran, 1999, 2000; Orbell & Verplanken, 2010
i. Promoting treatment initiation	Coping planning	Specifying plans to overcome anticipated barriers to action and responses to relapse.	Johnson & Leventhal, 1974; Schwarzer, 2008
ii. Promoting longer-term behavioural maintenance/adherence	Habit	A specific form of cue-response association formed in memory as a consequence of repeated performance of a particular action in response to a particular cue context. Once formed, the context cue automatically elicits behavior.	O'Carroll, Chambers, Dennis, Sudlow & Johnston, 2014; Orbell & Verplanken, 2010; Phillips, Cohen, Burns, Abrams & Renninger, 2016; Phillips, Leventhal & Burns, 2013; Verplanken & Orbell, 2003; Wood & Runger, 2016;
iii. Overcoming existing, counter-intentional (health-compromising) habits	Habit discontinuity hypothesis	The proposition that context change removes an individual from existing behavioural cues and provides an opportunity for the individual to engage in motivated behaviour change.	Verplanken, Walker, Davis & Jurasek, 2008; Verplanken & Roy, 2016.
	Cueing/Priming interventions	A strategy for overcoming counter-intentional habits by altering the cues to the unhealthy behaviours or activating health directed goals.	Hollands et al., 2015; Papies, Potjes, Keesman, Schwinghammer & von Koningsbruggen, 2014; Papies, 2016
	Training new responses to cues	A strategy for overcoming counter-intentional habits by training new responses to existing cues.	Adriaanse, de Ridder, & de Witt, (2009); Adriaanse, Gollwitzer, de Ridder, de Wit & Kroese (2011)
	Inhibitory control training	A strategy for helping individuals overcome impulses to engage in health-risky behaviours by giving them repeated practice at self-regulation.	Allom, Mullan & Hagger, 2016;Wiers, Eberl, Rinck, Becker & Lindenmeyer, 2011

Figure 1. Representation of the Roles of Implicit Processes in Illness Self-Regulation.