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Positive affective processes underlie positive health behaviour change

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Positive health behaviours such as physical activity can prevent or reverse many chronic conditions, yet a majority of people fall short of leading a healthy lifestyle. Recent discoveries in affective science point to promising approaches to circumvent barriers to lifestyle change. Here, we present a new theoretical framework that integrates scientific knowledge about positive affect with that on implicit processes. The *upward spiral theory of lifestyle change* explains how positive affect can facilitate long-term adherence to positive health behaviours. The inner loop of this spiral model identifies nonconscious motives as a central mechanism of behavioural maintenance. Positive affect experienced during health behaviours increases incentive salience for cues associated with those behaviours, which in turn, implicitly guides attention and the everyday decisions to repeat those behaviours. The outer loop represents the evidence-backed claim, based on Fredrickson's broaden-and-build theory, that positive affect builds a suite of endogenous resources, which may in turn amplify the positive affect experienced during positive health behaviours and strengthen the nonconscious motives. We offer published and preliminary evidence in favour of the theory, contrast it to other dominant theories of health behaviour change, and highlight attendant implications for interventions that merit testing.

Keywords: positive affect; nonconscious; health behaviour change; broaden-and-build; positive psychology; prioritising positivity

By 2020, the World Health Organization expects that chronic diseases (e.g. cardiovascular disease, diabetes, asthma, arthritis and cancer) will account for almost three-quarters of all deaths worldwide (World Health Organization, 2002). In the US alone, by the time adults reach age 50, 70% have been diagnosed with one or more chronic health conditions that can reduce their quality of life, workforce participation and lifespan (CDC & AARP, 2013; CDC, AARP, & AMA, 2009). Chronic diseases are also responsible for runaway healthcare costs that burden households, businesses and governments, and this impact is rapidly increasing worldwide, no longer limited to the developed regions of the world. Positive health behaviours such as physical activity or healthy eating can prevent or reverse risk for many chronic conditions (Haskell et al., 2007; World Health Organization, 2003, 2006). However, regarding physical activity, a striking number of people

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worldwide fall short of the overall minimum guidelines for physical activity. For example, in the US, 80% of adults (Harris et al., 2013) are insufficiently active and in Europe, 6 in every 10 people above age 15 years never or seldom exercise or play a sport, and more than half never or seldom engage in other kinds of physical activity, such as cycling, dancing or gardening (European Commission, 2014). Regarding obesity, its worldwide prevalence has also nearly doubled between 1980 and 2008. For example, 36% of adults are obese in the US (Ogden, Carroll, Fryar, & Flegal, 2015), and roughly 21% in Europe (World Health Organization, 2008). Although intentions to become and stay healthy are ubiquitous (as evident in perennial New Year's resolutions), lifestyle change is difficult to achieve because people's intentions to be active and healthy yield only trivial changes in actual behaviour (Rhodes & Dickau, 2012; Sheeran, 2002).

In this paper, we focus primarily on two of the most extensively studied positive health behaviours, physical activity and healthy eating, each of which promotes health and prevents diseases (Macera, 2003). We also include work on meditation, which our team has studied and considers a positive health behaviour for its effects on reducing depressive symptoms (Fredrickson, Cohn, Coffey, Pek, & Finkel, 2008), chronic stress and anxiety (e.g. Gotink et al., 2015; Spijkerman, Pots, & Bohlmeijer, 2016), and high blood pressure (Bai et al., 2015), and increasing psychosocial well-being with corresponding changes in markers of immune activity (Fang et al., 2010, Kok et al., 2013).

Significance of positive affect during health behaviours

Discoveries in affective science point to promising approaches to circumvent barriers to lifestyle change. Generally speaking, when people associate enjoyment with the thought of engaging in a health behaviour, they are more likely both to intend to engage in that health behaviour, and to actually engage in it (Kiviniemi & Duangdao, 2009; Kiviniemi, Voss-Humke, & Seifert, 2007; Lawton, Conner, & McEachan, 2009). Across a range of health behaviours (including physical activity and eating fruits and vegetables), this effect of positive affective attitudes (i.e. that a behaviour is seen as enjoyable) has been found to be even stronger than the effects of positive cognitive attitudes (i.e. that a behaviour is seen as beneficial; Lawton et al., 2009). The strongest support for this idea comes from research on physical activity: a recent meta-analysis of 82 studies reported a medium to large effect size between people's positive affective judgments about the experience of physical activity and their overall physical activity, which exceeds effect sizes for other predictors of physical activity that receive greater empirical attention (i.e. self-efficacy, the social and built environment; Rhodes, Fiala, & Conner, 2009). Importantly, positive affective judgments about physical activity are unmoved by interventions that deploy persuasive information or target self-regulation skills; personally experienced pleasant affect appears to be key (Rhodes et al., 2009; Williams, 2008). Moreover, *when* that pleasant affect is experienced is critical to forecasting subsequent behavioural engagement. Affective boosts experienced *during* physical activity appear to be especially important in this regard: a recent systematic analysis of 24 studies concluded that pleasant affect experienced during physical activity forecasts people's future physical activity, whereas pleasant affect experienced after physical activity does not (Rhodes & Kates, 2015). The predictive effects of positive affect felt during activity engagement hold even among initially sedentary adults at 6- and 12-month follow-up (Williams et al., 2008; Williams, Dunsiger, Jennings, & Marcus, 2012).

Similar patterns have emerged within the domain of another health behaviour, namely, meditation. Specifically, novice meditators who were one standard deviation above the mean in their positive affective responses to meditation were over 4 times more likely to maintain that behaviour 15 months later, compared to those one standard deviation below the mean (Cohn & Fredrickson, 2010). The extent of people's early positive affective reactivity to meditation was the sole psychological predictor of whether, more than one year later, they voluntarily chose to continue meditating as a regular habit.

Evidence from multiple domains, then, suggests that positive affect,¹ particularly when experienced during positive health behaviours, is consequential for long-term behavioural maintenance. Lacking, however, is a comprehensive theoretical framework that unpacks the mechanisms through which positive affect alters future health-related decision-making. To better understand positive health behavioural maintenance, here we present a new theoretical framework that integrates scientific knowledge about positive affect with that on implicit processes. We also highlight attendant implications for interventions that merit testing.

Upward spiral theory of lifestyle change

Existing theoretical accounts for the role of positive affect in future health behaviour engagement rest largely on learned associations, whereby actions that are rewarding or satisfying are more likely to be maintained (Lawton et al., 2009; Rhodes et al., 2009; Rhodes & Kates, 2015; Williams, 2008). Pushing for a deeper understanding of underlying mechanisms, the *upward spiral theory of lifestyle change* draws on discoveries in behavioural neuroscience that unpack complex reward systems into separate 'liking', 'wanting' and 'learning' systems. Specifically, the *incentive salience theory of addiction* (Berridge, 2007; Smith, Berridge, & Aldridge, 2011) holds that dopaminergic activity does not account for reward in a general sense, but rather only the subcomponent of wanting (Berridge, 2007). The subcomponent of liking, by contrast, is underpinned by the brain's release of other neurochemicals, such as enkephalin (Kringelbach & Berridge, 2012). Over time, associations between pleasantness (liking) and cues predictive of it endow those cues with *incentive salience*, making them more likely to capture attention in the future. When those cues are subsequently encountered, their heightened salience triggers dopaminergic wanting and seeking behaviours. Although much of the foundational support for incentive-salience theory comes from rodent models (Cagniard, Balsam, Brunner, & Zhuang, 2005; Pecina, Cagniard, Berridge, Aldridge, & Zhuang, 2003), a clever paradigm has recently illustrated how incentive salience operates in humans (Ode, Winters, & Robinson, 2012). In that research, participants viewed sequential word stimuli that were affectively positive, negative or neutral, and estimated the font size of the text in which each of the stimulus words was presented. Consistent with incentive salience theory, participants' responses indicated that positively valenced words were perceived as larger than neutral or negative words. Incentive salience thus illuminates the automatic, often nonconscious processes positioned between 'liking' a given activity and subsequent and persistent behavioural urges to reenact it ('wanting').

Further, the *broaden-and-build theory of positive emotions* (Fredrickson, 1998, 2001, 2013) provides a theoretical framework to explain how positive affect creates sustained and increasing motives for positive health behaviours. In brief, the

broaden-and-build theory posits that experiences of positive emotions (e.g. joy, gratitude, interest, pride, serenity) momentarily broaden people’s mindsets in ways that, over time, accumulate and compound to build biological resources (e.g. cardiac vagal tone) as well as cognitive (e.g. mindfulness), psychological (e.g. purpose in life) and social (e.g. positive relations with others) resources (See for a summary of evidence supporting the theory, Fredrickson, 2013).

Weaving together insights from the incentive salience theory with the broaden-and-build theory, Fredrickson (2013) has outlined the *upward spiral theory of lifestyle change* to explain how positive affect can facilitate long-term adherence to positive health behaviours. This theory holds that, to the extent that positive affect is experienced during a new health behaviour, it creates nonconscious motives for that activity, which grow stronger over time as they are increasingly supported by certain personal resources – biological, cognitive, psychological and social – that positive affect serves to build. As such, the theory is well positioned to illuminate the sustained behavioural maintenance that comprises successful lifestyle change. Figure 1 depicts the recursive dynamic processes articulated by the upward spiral theory.

The inner loop of this spiral model identifies nonconscious motives as a central mechanism that accounts for behavioural maintenance. It suggests that positive affect experienced during health behaviours incrementally increases incentive salience for cues associated with those behaviours. In turn, heightened incentive salience implicitly guides attention and the quotidian decisions that incrementally set people on trajectories towards healthy lifestyles. The outer loop represents the evidence-backed claim, based on the broaden-and-build theory, that positive affect builds a suite of endogenous resources (Fredrickson, 2013; Fredrickson et al., 2008; Kok et al., 2013). Following Pluess and Belsky (2013), we identify these resources as *vantage resources* to the extent that they render people more sensitive to subsequent positive experiences.

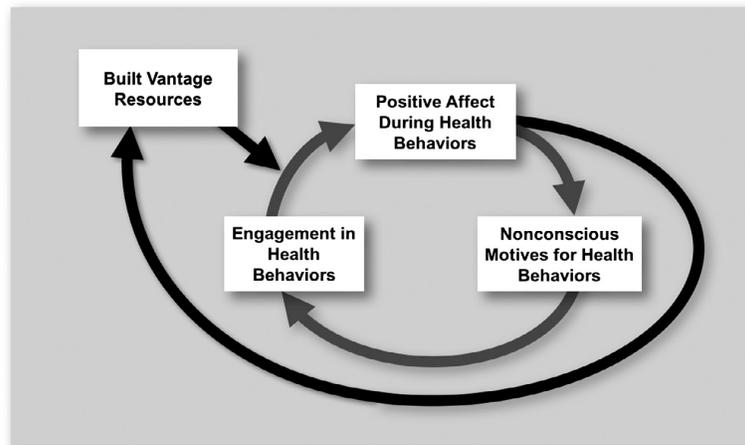


Figure 1. Upward spiral theory of lifestyle change. The inner loop is in grey. The outer loop is in black.

As such, just as certain malleable risk factors (e.g. obesity, pessimism, loneliness) deter health, certain malleable vantage resources (e.g. cardiac vagal tone, broad-minded coping, social integration) support health. Vantage resources, we argue, support people's efforts to maintain a healthy lifestyle by amplifying (moderating) the positive affect experienced during positive health behaviours. This greater positive affect, in turn, further strengthens nonconscious motives via the inner loop. We offer, in the sections that follow, an extension of the brief description in Fredrickson (2013) of the upward spiral theory of the of lifestyle change. We first unpack the theory into its two interrelated loops, and provide new evidence supporting key theorised processes. Second, we discuss the theory in relation to other existing theories in health behaviour change. Finally, we provide specific recommendations for future theory-driven research and intervention development.

Evidence for the upward spiral's inner loop: positive affect and nonconscious motives

The inner loop of the model (see Figure 1, grey loop) describes an implicit psychological mechanism hypothesised to explain *how* positive affect can support the maintenance of positive health behaviours. It suggests that positive affect experienced during a positive health behaviour creates nonconscious motives for cues associated with that health behaviour, motives that in turn support subsequent and repeated decisions to engage in that behaviour.

Existing research on health behaviour change places undue emphasis on conscious deliberations (Ekkekakis, Parfitt, & Petruzzello, 2011; Rhodes & Kates, 2015). Research has shown, however, that many behavioural decisions are directly influenced by non-conscious motives (Iso-Ahola, 2013; Marteau, Hollands, & Fletcher, 2012; Sheeran, Gollwitzer, & Bargh, 2013). Specifically, evidence suggests that priming concepts related to a behaviour or goal can motivate individuals to pursue those behaviours and goals even without conscious awareness of this motivation or its origin (Payne, Brown-Iannuzzi, & Loersch, 2016). Strategies such as implementation intentions (or if-then planning) for example, leverage this mechanism to boost health behaviour initiation by creating an implicit relation between an anticipated critical situation (opportunity or obstacle) and a goal relevant response (Gollwitzer, 1999).

Critically, laboratory experiments have also pinpointed positive affect as particularly influential in the operation of nonconscious motives. In one experiment (Aarts, Custers, & Marien, 2008), nonconscious primes for exertion were paired with positive affect, or not, and also benchmarked against a control condition in which nonconscious primes were absent, but positive affect was present. Comparing handgrip force across these three conditions revealed that when exertion and positive affect were linked, participants used the greatest force to execute their responses – consistent with the idea that positive affect energises action. Across six other experiments (Custers & Aarts, 2005), priming goal behaviours together with positive affect increased participants' wanting to pursue these behavioural goals and motivated participants to work harder on tasks that were instrumental in attaining them. Such effects emerge even without conscious awareness of the source of the increased motivation. These and other studies suggest that, to the extent that nonconscious goal priming is paired with positive affect, additional motivation is unleashed: people become more likely to want, initiate and sustain actions for the attainment of nonconsciously primed goals (Custers & Aarts, 2007).

Related experimental work suggests that merely inducing positive affect can non-consciously activate physical activity goals. Participants randomly assigned to experience positive affect showed heightened responses to physical activity words, relative to control participants, on a lexical decision task (Cameron, Bertenshaw, & Sheeran, *in press*). Induced positive affect also caused participants to broaden their physical activity repertoires, evidenced by their expressed intentions to undertake more distinct physical activities and being open to trying more new physical activities (Cameron et al., *in press*).

Recent work by our team indexes nonconscious motives as the relative pleasantness of activity-related thoughts that spontaneously come to mind (Rice & Fredrickson, 2016). To the extent that incentive salience entails heightened activation of mental concepts associated with previously enjoyed stimuli, such concepts may more readily emerge into conscious awareness in the form of positive spontaneous thoughts. Data obtained from a thought-listing task revealed that, as hypothesised, positive spontaneous thoughts were modestly correlated with a previously validated index of incentive salience: estimated font size of a target word (Rice & Fredrickson, 2017; Study 2). Whereas prior work demonstrated that incentive salience makes cues associated with reward visually loom larger in the eyes of perceivers (Ode et al., 2012; Veltkamp, Aarts, & Custers, 2008), these preliminary results suggest that those cues loom larger in their minds as well.

Using this new index of nonconscious motives, our team has found that experienced positive affect shapes positive spontaneous thoughts. Building on preliminary correlational evidence (Rice & Fredrickson, 2017; Study 1), we conducted a laboratory experiment to determine whether the manipulation of pleasantness would alter subsequent patterns of positive spontaneous thoughts about an associated target. Thought-listing data revealed that participants randomly assigned to view a set of relatively more enjoyable cartoons subsequently reported spontaneous thoughts about those cartoons that were more positively valenced than the spontaneous thoughts reported by participants who viewed less amusing cartoons (Rice & Fredrickson, 2017; Study 2). Moreover, a 12-week diary study revealed that the positive affect people experienced during physical activity predicted subsequent increases in the positivity of their spontaneous thoughts about physical activity, and critically that those spontaneous thoughts in turn predicted increases in the frequency and duration of physical activity (Rice, 2016, Study 3). These results provide initial evidence, in the domain of physical activity, that positive affect during a positive health behaviour creates nonconscious motives for that health behaviour, which in turn predict engagement in that behaviour.

Interestingly, although positive affective experiences spark consequential nonconscious motives, the conscious perception that one's spontaneous thoughts are positive may also increase behavioural intentions. We conducted an additional laboratory experiment that used false feedback to test whether perceiving one's own spontaneous thoughts about a physical activity as notably positive is sufficient to alter subsequent behavioural intentions for that activity. Results revealed that participants randomly assigned to receive false feedback that described their spontaneous thoughts about a target physical activity as especially positive planned to devote more time to that activity in the coming week, relative to participants who received no such message (Rice & Fredrickson, 2017, Study 3).

In sum, past research has shown that health behaviours experienced as pleasant are more likely to be maintained (Cohn & Fredrickson, 2010; Rhodes & Kates, 2015; Woolley & Fishbach, 2016a, 2016b). The mechanisms underlying this important effect have remained underdeveloped. The inner loop of the upward spiral theory provides a model to illuminate the psychological mechanisms that determine how pleasant behaviours are more likely to be maintained, even outside of conscious awareness. Converging evidence from distinct lines of research suggests that positive affective experiences initiate a cascade of nonconscious or spontaneous cognitive processes that may orient the individual to repeat the previously enjoyed behaviours.

Evidence for the upward spiral theory's outer loop: modifiable vantage resources for health decision-making

People vary – from one another and over time – in the extent to which they derive pleasant affect from positive health behaviours (e.g. Ekkekakis, Hargreaves, & Parfitt, 2013). For example, the research literature on health behaviour change has uncovered limiting factors, which *reduce* the extent to which one can derive pleasant affect from health behaviours. For example, the lack of social resources (e.g. poor social support), physical resources (e.g. physical limitations, unaccommodating built environment, restricted time), psychological resources (e.g. being tired, depressed, chronically stressed) and socio-economic status (e.g. financial challenges), are important factors to consider in studies of pleasant affect derived from health behaviours (e.g. Giles-Corti & Donovan, 2002; Lappalainen et al., 1997; Olano et al., 2015; Pate et al., 1995). The upward spiral theory of lifestyle change adds to this research literature by spotlighting *vantage* resources, whether biological, cognitive, psychological or social. The outer loop (see Figure 1, black loop) draws on the broaden-and-build theory of positive emotions (e.g. Fredrickson, 2013) to explain how variation in certain vantage resources amplifies (moderates) the positive affect gained from positive health behaviours *and* how these vantage resources are in turn further augmented by the experience of positive affect. These reciprocal effects also foster the dynamics of upward spirals. Below, we focus on a subset of biological and psychological variables that have been shown to function as vantage resources.

One biological vantage resource that our team has studied is cardiac vagal tone, which refers to the function of the vagus nerve, a key component of the parasympathetic nervous system. The vagus nerve regulates many internal organs, including the heart, lungs and digestive system by sending the message to support the body to rest, digest and connect (Porges, 2007). Cardiac vagal tone is an index of autonomic flexibility, emotional flexibility and physical health. Low vagal tone, for instance, has been linked to high fasting glucose, overnight urinary cortisol and inflammation (Thayer & Sternberg, 2006). Critical to the present theory, cardiac vagal tone is improved by health behaviours and experiences of positive emotions, and in turn appears to modulate the emotional reactions to health behaviours. Supportive initial evidence comes from a longitudinal field experiment in which mid-aged adults were randomly assigned to attend a six-week workshop that taught the positive health behaviour of meditation (focused on loving-kindness) or to serve in a monitoring, waitlist control group (Kok et al., 2013). All participants reported their levels of 10 distinct positive emotions daily. Participants' high-frequency heart rate variability (HF-HRV) at rest, an index of cardiac

vagal tone, was measured at baseline and nine weeks later, at the end of the study. Results indicated that baseline HF-HRV amplified (moderated) the positive affect that stemmed from meditation. In turn, HF-HRV showed improvements over time to the extent that participants' meditation practice evoked positive affect and positive social connections. In addition, to the extent that HF-HRV is a correlate of cardiorespiratory fitness (Buchheit & Gindre, 2006), it also stands both to enhance positive affect during physical activity, and to be augmented further by repeated decisions to be physically active. Cardiac vagal tone thus appears to be one biological vantage resource that may leverage upward spiral dynamics.

Recent evidence from our team suggests that the oxytocin system may also serve as a vantage resource that fuels upward spiral dynamics. Using a similar longitudinal experimental design (i.e. six-week meditation workshops, daily reports of positive emotions) we found that a common genetic variant associated with oxytocin signalling predicted the degree to which mid-aged participants reported positive affect in response to loving-kindness meditation (Isgett, Algoe, Boulton, Way, & Fredrickson, 2016). In another study (Van Cappellen, Way, Isgett, & Fredrickson, 2016), we found that dual-blind administration of exogenous oxytocin vs. a placebo increased mid-aged men's positive affective responses – assessed with both implicit and explicit measures – to an initial 20-minute introduction to meditation, with effects especially evident for meaningful and self-transcendent affective experiences, such as gratitude and awe (Van Cappellen, *in press*). Future work is needed to investigate whether the oxytocin system influences positive affective responses to health behaviours other than meditation.

Among psychological vantage resources, flourishing mental health, characterised by the lack of mental illness as well as the presence of positive functioning (e.g. self-acceptance; Keyes, 2005), was found to increase (moderate) positive affect during a range of behaviours that contribute to well-being (e.g. interacting with others, helping, spiritual activity). These heightened positive affective reactions, in turn forecasted future increases in flourishing, months later (Catalino & Fredrickson, 2011). Other research shows that positive affect and individual differences in emotion regulation strategies (i.e. positive reappraisal and mindfulness, Garland, Gaylord, & Fredrickson, 2011), positive coping (Burns et al., 2008) and broad-minded coping (Fredrickson & Joiner, 2002) reciprocally and prospectively enhance one another and are therefore potential good candidates to be vantage resources in the specific context of positive health behaviours.

Another psychological resource that both amplifies the positive affect people extract from positive health behaviours, and appears to be built through recurrent experiences of positive affect, is the individual difference of prioritising positivity. Prioritising positivity is the tendency to structure daily life to include pleasant experiences (example item, 'I structure my day to maximize my happiness', Catalino, Algoe, & Fredrickson, 2014). In a field study, our team has uncovered preliminary evidence that people scoring higher on a self-report measure of prioritising positivity report greater positive affect in response to positive health behaviours. Mid-aged adults learned one of two types of meditation over a six-week workshop and reported daily on the emotions they felt while meditating. We discovered that prioritising positivity appeared to amplify the positive affect people experienced when engaging in meditation, even after adjusting for participants' typical levels of positivity (Catalino, Van Cappellen, Boulton, Firestone, & Fredrickson, 2017). In this same longitudinal study, participants also provided daily reports of physical activity engagement, and, if active, the positive affect they

experienced in their chosen activity. Results showed that those scoring higher on prioritising positivity reported greater positive affect during bouts of physical activity, an effect that also remained significant after controlling for participants' typical levels of positivity (Catalino et al., 2017). In addition, Datu and King (2016), in a longitudinal study, found reciprocal relations between prioritising positivity and positive affect in daily life.

In sum, the outer loop of the model addresses variation over time and across people in the extraction of pleasant affect during positive health behaviours. In addition, the outer loop modulates the inner loop, and in doing so illuminates when and for whom vantage resources predict *increasing* enjoyment of positive health behaviours. Two important implications follow from the outer loop of the model. First, ample past research has documented natural declines in the enjoyment of recurrent experiences due to adaptation, termed the hedonic treadmill (Brickman & Campbell, 1971; Diener, Lucas, & Scollon, 2006). The endogenous vantage resources built via the outer loop of the model may function to counteract such adaptation (Fredrickson et al., 2008). For example, interventions that have taught people how to self-generate positive affect have shown *increased* effectiveness over time (Fredrickson et al., 2008; Moskowitz et al., 2017). Second, the broaden-and-build theory featured in the outer loop asserts that positive emotions create *flexible* patterns of thoughts and behavioural actions. This flexibility may protect against a potentially rigid or obsessive pursuit of positive health behaviours by building harmonious passion for those behaviours (for relevant research on obsessive passion, see Vallerand, 2010; see also Rice & Fredrickson, 2016 for the relations among harmonious passion, incentive salience and physical activity). Positive emotions may also also render people more flexible and creative in finding solutions when their behavioural goals get derailed or when a particular health behaviour no longer evokes positive affect.

Upward spiral theory compared to other theories of health behaviour change

The upward spiral theory does not replace but rather complements other theories of health behaviour change by shedding light on understudied affective, nonconscious and growth-related processes, namely, (1) positive affect experienced during positive health behaviours, (2) nonconscious motives related to incentive salience and (3) modifiable vantage resources that support increasing and nonconscious motives for positive health behaviour change. In addition, whereas other theories of health behaviour change largely centre on behavioural initiations, the upward spiral theory centres on the long-term behavioural maintenance that defines lifestyle change. Here, we first briefly describe the points of overlap and difference between the upward spiral theory and four dominant theories for health behaviour change: the transtheoretical model (Prochaska & Velicer, 1997), goal setting theory (Locke & Latham, 1990), social cognitive theory (Bandura, 1991) and the theory of planned behaviour (Ajzen, 1991; Godin & Kok, 1996). We then discuss the upward spiral theory in comparison to related theories, or iterations thereof, that have more explicitly addressed affective mechanisms (e.g. theory concerning fear appeals and protection motivation, Rogers, 1983).

The construct of 'stage of change' is a key element of the transtheoretical model (TTM) of health behaviour change (Prochaska & Velicer, 1997). The TTM proposes that people can be at different stages of readiness to adopt healthful behaviours:

precontemplation, contemplation, preparation, action, maintenance and termination. In relation to the TTM, the upward spiral theory concerns the later stages of change, i.e. action, maintenance and termination. We suggest that once a new health behaviour is enacted with concurrent experiences of positive affect, then the implicit processes identified by the upward spiral theory of lifestyle change ensue.

Goal-setting theory is another widely used theory, which holds that individuals who set hard and specific goals for health behaviour change perform better than those who set easy or abstract goals (as long as the person has the necessary ability to reach the goal and does not have conflicting goals). In relation to goal-setting theory, the upward spiral theory specifies an additional condition necessary to render goals for behavioural change more likely to be sustained in the long term. Specifically, the upward spiral theory suggests that individuals who work towards hard and specific goals for positive health behaviours that evoke positive emotions (e.g. pride, joy) during behavioural enactment will be more likely to sustain behavioural maintenance.

A limitation to the theories of health behaviour change cited above is the common focus on change in behavioural *intentions* (i.e. earlier stages in the TTM). The assumption is that people with the right intentions will be able to summon the willpower to enact their intended behavioural changes. People's conscious behavioural intentions, however, often do not align with their actual behavioural engagement, a mismatch termed the intention-behaviour gap (Sheeran, 2002). That is, many people, despite having the support, the means, and the beliefs that they can initiate positive health behaviours, fail to adopt or sustain healthy habits.

Moreover, each of these dominant theories rests, to some extent, on *conscious* behavioural intentions. Social cognitive theory (Bandura, 1991), in particular, frames behaviour change as relying on conscious self-monitoring and the deliberate exercise of self-influence. The concept of self-efficacy, the belief that one has the ability to perform a specific behaviour that will bring about desired outcomes, is a key component of social cognitive theory, one that is also relevant to the upward spiral theory (Strecher, McEvoy DeVellis, Becker, & Rosenstock, 1986). Self-efficacy, for instance, may be central to individuals' ability to identify and enact positive health behaviours that are anticipated to spark positive affect. Concepts related to agency and self-efficacy have also been co-opted into other dominant theories of health behaviour change. The theory of planned behaviour (Ajzen, 1991; Godin & Kok, 1996), for instance, unpacks the formation of conscious behavioural intentions as a function of attitudes towards a behaviour (general evaluation of the behaviour as positive or negative), subjective norms (how much peers support one's engagement in a behaviour) and perceived behavioural control (how much one has control over the realisation of the behaviour). However, research shows that people's day-to-day health behaviours often defy conscious willpower and are instead shaped by implicit emotions and nonconscious motives (Iso-Ahola, 2013; Marteau et al., 2012; Sheeran et al., 2013). Moreover, the processes that guide people's day-to-day health decisions change as they move beyond initiating a new health behaviour into the habitual maintenance of it (Rothman, 2000; Rothman, Baldwin, Hertel, & Fuglestad, 2011), with the impact of nonconscious (vs. conscious) processes becoming stronger over time (Papies & Aarts, 2011).

Whereas the theory of planned behaviour and other dominant theories of health behaviour change are silent on the influence of nonconscious processes, the upward spiral theory pinpoints positive affect experienced during positive health behaviours as the

source of (1) nonconscious motives to repeat positive health behaviours, (2) increasingly positive attitudes towards positive health behaviours and (3) the accrual of vantage resources, such as resilience, harmonious passion and flexibility, that may impact perceived behavioural control.

Whereas most classic theories of health behaviour change rest on rationally made decisions that weigh the costs and benefits of adopting a new behaviour, other, often newer theories spotlight affective processes. Perhaps the earliest to do so pertains to fear appeals and protection motivations. According to this approach, one strategy to modify a person's intention to initiate a given health behaviour is to induce fear by increasing perceptions of the probability that a health threat will occur. When such fear appeals are connected to a recommended preventive health behaviour, then the intention to adopt this health behaviour is said to increase. One limit of this theory is that it only applies to situations involving threat and it makes fear a condition for behaviour change. This is problematic for multiple reasons. First, healthy lifestyles are valuable even if there is no direct or imminent threat to a person's health. Second, individuals do not always recognise objective threat when present. Finally, fear appeals and protection motivations do not capture the full range of motivations for health behaviour change, many of which are promotion-focused rather than prevention-focused (Higgins, 1998). As such, additional theories are needed to account for promotion-focused health behaviour change in non-threatening contexts. The upward spiral is one such theory.

Later iterations of Ajzen's theory of planned behaviour have also spotlighted affective processes (Ajzen & Driver, 1991). In studying the role of attitudes (overall evaluation of the behaviour) in predicting people's intentions to engage in a behaviour, two types of attitudes have been differentiated: cognitive (whether one evaluates the behaviour as beneficial) and affective (whether one associates the behaviour with a particular affective state). As mentioned previously, when affective attitudes towards health behaviours are positive, those attitudes predict behaviour engagement, over and above cognitive attitudes (e.g. Lawton et al., 2009). In a distinct body of research, another conceptualisation of affective attitudes has emerged, namely, anticipated affective reactions (Ajzen & Sheikh, 2013). These capture the feelings expected to *follow* the act of doing (e.g. relief, pride) or not doing (e.g. guilt) a behaviour. Most research has been concentrated on negative anticipated affect associated with not doing a behaviour, which predicts intention and behaviour. By contrast, positive anticipated affect associated with doing the behaviour has received far less attention (Conner, Godin, Sheeran, & Germain, 2013; Sandberg & Conner, 2008).

Providing further proof of principle that affective attitudes predict people's intention to engage in a behaviour, other research has tested whether it is possible to change, at least in the short term, people's affective attitudes towards the representation of a behaviour. The technique of evaluative conditioning is deployed here: pairing pictures of health behaviours with valenced stimuli, to investigate whether doing so modifies people's health behaviour decisions in a subsequent task. For example, Walsh and Kiviniemi (2014) primed participants with positive, neutral or negative affective pictures before showing pictures of fruits. They found that participants who saw fruit images paired with positive images (vs. neutral or negative) were more likely to select a fruit snack vs. a granola bar at the end of the lab study. Similar results using similar procedures for evaluative conditioning were also found in the domain of physical activity. Despite small sample size, participants who had preexisting negative affective attitudes

towards exercising but acquired more positive attitudes through an evaluative conditioning task were found to subsequently choose to ride a bicycle ergometer at a higher intensity, compared to participants in a control group (with varying levels of preexisting affective attitudes and for whom exercise-related images were paired with neutral instead of positive images, Antoniewicz & Brand, 2016).

The upward spiral theory of lifestyle change advances beyond affective attitudes and evaluative conditioning to deepen scientific understanding of the mechanisms (non-conscious processes and increasing vantage resources) through which these affective constructs operate. In addition, the upward spiral theory focuses on the affect associated with the actual enactment of a health behaviour and not with the idea or the representation of the health behaviour (e.g. affective attitudes are typically measured by asking someone how they feel when thinking about eating fruits). This difference is critical for two reasons. One is that positive affect experienced *during* a positive health behaviour appears to be particularly predictive of behavioural maintenance (Rhodes & Kates, 2015). Another is that personally experienced positive affect during behavioural enactment may be required to build resources that will in turn amplify the positive emotion yield of health behaviours and support their maintenance. Moreover, vantage resources are posited to increase over time, built through repeated experiences of positive emotions, which explains how affective effects can defy adaptation and instead grow in impact (Fredrickson et al., 2008; Moskowitz et al., 2017). As such, in contrast with the application of evaluative conditioning to health behaviour change, the upward spiral theory provides a rationale to understand not only behavioural initiation or short-term changes, but also long-term maintenance.

Despite the differences between the upward spiral theory and research on affective attitudes and evaluative conditioning, points of connection emerge as well. For instance, the upward spiral theory can be said to describe evaluative conditioning as it unfolds in natural, day-to-day circumstances, rather than in one-time, artificial laboratory settings. The upward spiral theory also describes how recurrent experiences of positive affect during a given category of health behaviours (e.g. jogging, or eating dark, leafy greens), little by little shape people's more general affective attitudes about that category of behaviours (e.g. I enjoy jogging; I like eating greens). Within the upward spiral model, these more general positive attitudes – built through the repeated experiences of positive affect *in situ* – may function as vantage resources that ultimately enhance (moderate) the positive affect felt within subsequent enactments of that behaviour.

Future directions: increasing positive affect during positive health behaviours

As articulated in the upward spiral theory of lifestyle change, positive affect during positive health behaviours is hypothesised to spark *nonconscious* (cf. inner loop) and *increasing* (cf. outer loop) motives to pursue that behaviour in the future. As such, increasing positive affect felt while engaging in positive health behaviours stands to trigger the hypothesised upward spiral dynamics. Interventions that boost such affective experiences merit investigation.

People pursue positivity in various ways, some more effective than others. Research shows, for instance, that when people deliberately try to maximise their current positive affect, with excessively high standards in mind, it ironically makes them feel worse (Catalino et al., 2014; Mauss, Tamir, Anderson, & Savino, 2011). Willfully upregulating

momentary pleasant affect during the enactment of health behaviours may thus backfire. This precaution is important to keep in mind when developing interventions to increase positive affect during positive health behaviours.

Our team's initial evidence suggests that a more effective approach to experiencing more positive affect during positive health behaviours is to 'prioritise positivity' at various stages of goal setting. A first stage would be activity selection, which involves strategically choosing more enjoyable health behaviours. This approach capitalises on the evidence that situation selection is one of the most successful strategies for affect regulation (Gross & Thompson, 2007). Our research has shown that scheduling regular pleasant events in daily life is an effective way to deliberately experience more positive affect (Catalino et al., 2014). For example, for some people, going for a run is experienced as a chore, whereas for others it is a joy. When choosing a health-enhancing activity, people can explicitly base their selection on the positive affect they anticipate during the activity. Research shows, for instance, that women who select types of exercise that they genuinely enjoy end up being more active than those who prioritise health or weight loss (Segar, Eccles, & Richardson, 2008, 2011). Importantly, preliminary evidence from our laboratory suggests that people can be taught to prioritise positivity when engaging in their positive health behaviours (Catalino et al., 2017; Van Cappellen, Catalino, Boulton, Firestone, & Fredrickson, 2017). In one study, for instance, we randomised participants to read one of two brief 'news articles' that presented scientific facts about positive emotions. Those in the experimental condition read about the benefits of positive emotions and prioritising pleasant experiences rather than forcing them. Those in the control condition read about the neuroscience of positive emotions, which presented no implications for daily life choices. Participants were subsequently asked to list all the activities they had 'on deck' for the coming Sunday, and later rated the pleasantness of each. Relative to the control condition, the top five activities reported by those induced to prioritise positivity were more pleasant (Catalino, Van Cappellen, & Fredrickson, 2016). Future interventions could be tailored to motivate individuals to prioritise positivity specifically when choosing physical activities or healthy foods.

A second stage at which prioritising positivity may operate is during activity engagement. While engaging in their selected activity, people high on prioritising positivity may be more likely to look for and nurture (not force) their positive affective experiences as they naturally occur, an approach that deploys the related yet distinct skills of mindfulness and savouring (Kiken, Lundberg, & Fredrickson, 2017). Studies described in the earlier section on the outer loop provide preliminary evidence that people who score higher on a self-report measure of prioritising positivity derive more positive emotions from physical activity and from meditation. Additional preliminary evidence again suggests that it is possible to teach people these skills. Specifically, using the same experimental manipulation based on news articles (described above), participants who learned about the benefits of positive emotions and prioritising (and not forcing) pleasant experiences reported greater savouring and experiences of love and compassion during a 20-minute introduction to loving-kindness meditation (Van Cappellen et al., 2017).

A third stage at which prioritising positivity may operate is at post-activity evaluation: after having engaged in their selected activity, people high on prioritising positivity may be more likely to monitor whether they actually experienced pleasant feelings during activity engagement. We speculate that people who score higher on prioritising

positivity may be more motivated to change the selected activity if it fails to yield positive affect. For example, if initial attempts to go for a run are unenjoyable, people who score higher on prioritising positivity may next time choose another activity, such as gardening. These first and third stages, activity selection and post-activity evaluation, may be particularly critical in overcoming common barriers to health behaviours such as not being in the mood, bad weather or seeing a healthy lifestyle as another chore. The upward spiral theory implies that such barriers are not best fought by willpower, but rather ought to be acknowledged and dealt with creatively. The goal shifts from rigidly adopting a healthy lifestyle regardless of how it feels to do so, to judiciously pursuing enjoyable health behaviours to support the long-term maintenance of the desired healthy lifestyle.

It thus appears possible to teach people to prioritise those positive health behaviours that, in their enactment, boost experiences of pleasant affect, and to derive more enjoyment from the health behaviours in which they already engage. Fully powered randomised controlled trials that meet these objectives would answer the call for intervention studies that modify the affective experience of physical activity (Rhodes & Kates, 2015).

Current limits

One boundary condition of the upward spiral theory of lifestyle change may be that it applies to increasing positive health behaviours (e.g. physical activity, healthy eating, meditation) more than reducing negative health behaviours (e.g. smoking, excessive alcohol consumption). One reason is that to reduce negative health behaviours, positive affect would need to be associated with *not* drinking alcohol excessively or *not* smoking. Although these eliciting situations are likely to occur (e.g. not being out of breath anymore after having stopped smoking or sleeping better when not drinking), absences of unpleasant experiences are less circumscribed and perhaps harder for people to recognise. A related reason is that the positive affect that may arise when refraining from negative health behaviours necessarily competes with the physical pleasures that arise when enacting negative health behaviours. For example, someone who ‘feels good’ when drinking excessive amounts of alcohol may already have undergone addiction-related neural sensitisation (Berridge, 2007), or otherwise use those good feelings to justify maintaining that unhealthy behaviour. Elsewhere, we distinguish between two forms of positive affect, i.e. positive emotions and physical pleasures (Fredrickson, 2001), and hypothesise here that only the former creates the dual-loop reciprocal processes articulated within the upward spiral of lifestyle change. Whereas physical pleasures may activate the inner loop, they may not broaden awareness in ways that build endogenous vantage resources, as indicated by the model’s outer loop (see Figure 1). Preliminary evidence indirectly suggests that pleasures may not trigger the same psychological processes as positive emotions. For example, positive emotions have been shown to broaden attention, which is not the case for pleasurable stimuli, such as pictures of delicious desserts (Fredrickson, 2013; Gable & Harmon-Jones, 2008).

Another limit of the upward spiral theory is the current paucity of direct tests of it within the domain of healthy lifestyle choices. Some of the evidence cited here, for instance, draws from research within domains not specifically tied to health behaviours (e.g. Rice & Fredrickson, 2017, Study 2). Rigorous experimental and longitudinal

research within the domain of positive health behaviours is needed to directly test the many hypotheses about positive health behaviour change that are articulated by the theory.

Finally, the upward spiral theory would benefit from articulating and testing its relations to socio-economic disparities and other barriers to lifestyle change that may reduce the extent to which positive emotions may be derived from positive health behaviours. Evidence suggests, for instance, that severe and chronic stress experienced in early childhood can produce a biological residue that alters affective and behavioural proclivities decades later (Miller, Chen, & Parker, 2011; Shonkoff, Boyce, & McEwen, 2009). Less known is whether and how such changes are reversible later in life. However, animal research suggests that if early adversity increases the risk for vulnerability in later life, positive experiences (e.g. maternal warmth) can decrease such risk (See Shonkoff et al., 2009). Intervening early in life appears to be especially important to prevent entrenched health disparities and bad health behaviour habits later in life. The present model could be applied for children growing in low SES household. In addition, its focus on positive affect may be particularly relevant given the known relation between positive emotions and coping with stress (e.g. Folkman & Moskowitz, 2000). Additionally, resources such as finances, access to conducive built environments (e.g. parks, recreation centres) and natural environments (e.g. oceans, forests) are less mutable than the vantage resources identified in the upward spiral theory. Even so, the upward spiral theory suggests that people who can find ways – within their current contexts – to be creative and flexible in their efforts to maximise positivity during positive health behaviours may fare better than others in those same contexts. Still, we acknowledge that such entrenched limiting factors may reduce the likelihood of experiencing positivity during health behaviours or overwhelm the influence of more subtle nonconscious processes.

Conclusion

Recent studies, primarily regarding physical activity and meditation, suggest that the positive affect experienced during these positive health behaviours may forecast people's continued engagement in them. Illuminating possible mechanisms for this effect, the upward spiral theory of lifestyle change holds that positive affect experienced during positive health behaviours predicts subsequent increases in *nonconscious motives* for those health behaviours, which in turn predict future engagement in them (Rice & Fredrickson, 2017, Study 3). In addition, over time these positive affective boosts function to build endogenous vantage resources. Whether biological (e.g. cardiac vagal tone), cognitive (e.g. mindfulness), psychological (e.g. prioritising positivity) or social (e.g. social integration), these vantage resources *increase* the coupling between positive health behaviours and positive affect. Accordingly, interventions that boost the positive affect experienced during positive health behaviours stand to facilitate repeated decisions to engage in those health behaviours by cultivating *nonconscious* and *increasing* motives for those behaviours. Future research should focus on developing effective strategies to modify the affective experience of positive health behaviours. We suggest that people who prioritise positivity in their day-to-day choices of whether and how to lead their desired healthy lifestyle may be more likely to show long-term sustained adherence to that lifestyle.

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Note

1. Given the demonstrated independence of positive and negative affect (Watson, Clark, & Tellegen, 1988), studies cited here and the proposed theory focus on positive affect. The functions of positive affect in health behaviours are largely independent of negative affect. Of course, negative affect may well be experienced alongside positive affect, for example during exercise among sedentary individuals. We expect that when the balance between positive and negative affect tip to the positive, the processes described below in the upward spiral theory of lifestyle change will occur.

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