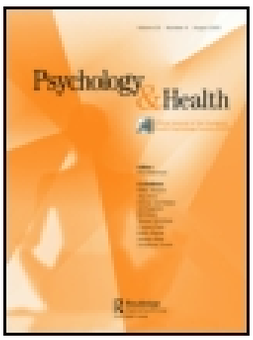

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Mediation, moderation, and context: Understanding complex relations among cognition, affect, and health behaviour

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Mediation, moderation, and context: Understanding complex relations among cognition, affect, and health behaviour

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Objective: Researchers have historically treated cognition and affect as separate constructs in motivating health behaviour. We present a framework and empirical evidence for complex relations between cognition and affect in predicting health behaviour.
Main Outcome, Design and Results: First, affect and cognition can mediate each other's relation to health behaviour. Second, affect and cognition can moderate the other's impact. Third, context can change the interplay of affect and cognition. Fourth, affect and cognition may be indelibly fused in some psychological constructs (e.g. worry, anticipated regret and reactance). These four propositions in our framework are not mutually exclusive.
Conclusion: Examination of the types of complex relations described here can benefit theory development, empirical testing of theories and intervention design. Doing so will advance the understanding of mechanisms involved in regulation of health behaviours and the effectiveness of interventions to change health behaviours.

Keywords: affect; cognition; health behaviour; relations among variables

A 55-year-old man is considering having a colonoscopy to screen for colorectal cancer. On hearing about the procedure's potential benefits and harms, he focuses on the possibility of bowel perforation, becomes afraid, and does not get screened. A 12-year-old girl is deciding whether to use her remaining lunch money to get an apple or to save the money for an ice cream cone. She finds herself both imagining how happy she will feel after eating the ice cream and remembering the health benefits of fruit and vegetable consumption. She decides to save her lunch money and get the ice cream later.

These examples share common features that define the scope of this paper. First, in each the outcome is either a health behaviour or an intention to engage in a health behaviour. Second, in each case determinants of that outcome are a combination of thoughts (e.g. the health benefits of the apple) and feelings (e.g. fear about the colonoscopy procedure) regarding the potential behaviour. The focus of our paper is on how researchers theorise about situations in which a health behaviour is determined by some

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combination of affect/feelings and cognition/thoughts. When affect and cognition combine to influence health behaviour, what is the nature of that combination? Below, we provide a framework with four different types of relations between affect and cognition that researchers might consider when theorising about these constructs as motivators of health behaviour and when developing interventions to change health behaviours.

Our focus will be on affects and cognitions that are linked to or evoked by a health behaviour (e.g. fears about a medical procedure, beliefs about the benefits of physical activity) or a health threat (e.g. worry about acquiring a sexual transmitted disease, knowledge of the causes of heart disease). The types of constructs considered in our framework take a variety of forms (e.g. knowledge, beliefs, attitudes, fear, worry and pleasure); the common feature is that the affect or cognition is about, associated with, or evoked by the threat or health behaviour.

When we use the terms 'affect', 'feelings' or 'affective influences', we generally refer to either a diffuse, valenced arousal state (e.g. feeling good or bad; the classic definition of an affective state) or a specific, labelled and valenced arousal state (e.g. happiness, fear, anger, contentment; the classic definition of an emotion). In a few cases, the distinction between affective states and emotions is important, but by and large our framework treats the two constructs as interchangeable. When we use the terms 'cognitions', 'thoughts', or 'cognitive influences', we refer to the class of social cognitive variables that are included in many health behaviour models, such as perceived susceptibility to harm, perceived benefits of the behaviour, and self-efficacy. Given this focus, our paper excludes some affective and cognitive constructs that are not tied to a specific health behaviour or health threat (e.g. incidental affect or mood; Ferrer et al., 2015; Lerner, Li, Valdesolo, & Kassam, 2015).

Much of the early foundational work on determinants of health behaviour had a strongly cognitive focus (for discussion see Kiviniemi, Voss-Humke, & Seifert, 2007; Manstead & Parker, 1995; van der Pligt, Zeelenberg, van Dijk, de Vries, & Richard, 1997), with nearly exclusive attention paid to constructs such as risk beliefs and perceived norms. Over the past 10–15 years, scientists have increasingly recognised the importance of affect in understanding health behaviour (DeSteno, Gross, & Kubzansky, 2013; Lerner et al., 2015). It is unlikely at this juncture that anyone would argue that affective factors do not play a role in regulation of many health behaviours. However, the intricacies and complexities of the role of affect within the context of motivating health behaviour have been underappreciated in most theorising and empirical work, particularly with regard to the interplay of affect and cognition.

Most work on the role of affect and cognition in motivating health behaviour has taken an isolated, main effects approach (see Figure 1(a)). For example, fear of a medical procedure influences the likelihood of undergoing the procedure and beliefs about the benefits of engaging in a behaviour influence the likelihood of doing so (e.g. Denberg et al., 2005; Dunton & Vaughan, 2008; Jandorf et al., 2010). This work often construes affect and cognition as having separate main effects and does not address their interplay, beyond potentially including both in a multivariable model (e.g. modeling affective components of attitudes in addition to cognitions, Ajzen & Driver, 1991, 1992). Furthermore, some work considers thoughts and feelings as competitive influences, examining which of the two has the stronger influence on behaviour (e.g. relative strength of affective versus cognitive attitude components as predictors of health behaviours, Lawton, Conner, & McEachan, 2009; Lawton, Conner, & Parker, 2007). However, this research does not consider possible interconnections of thought and feeling.

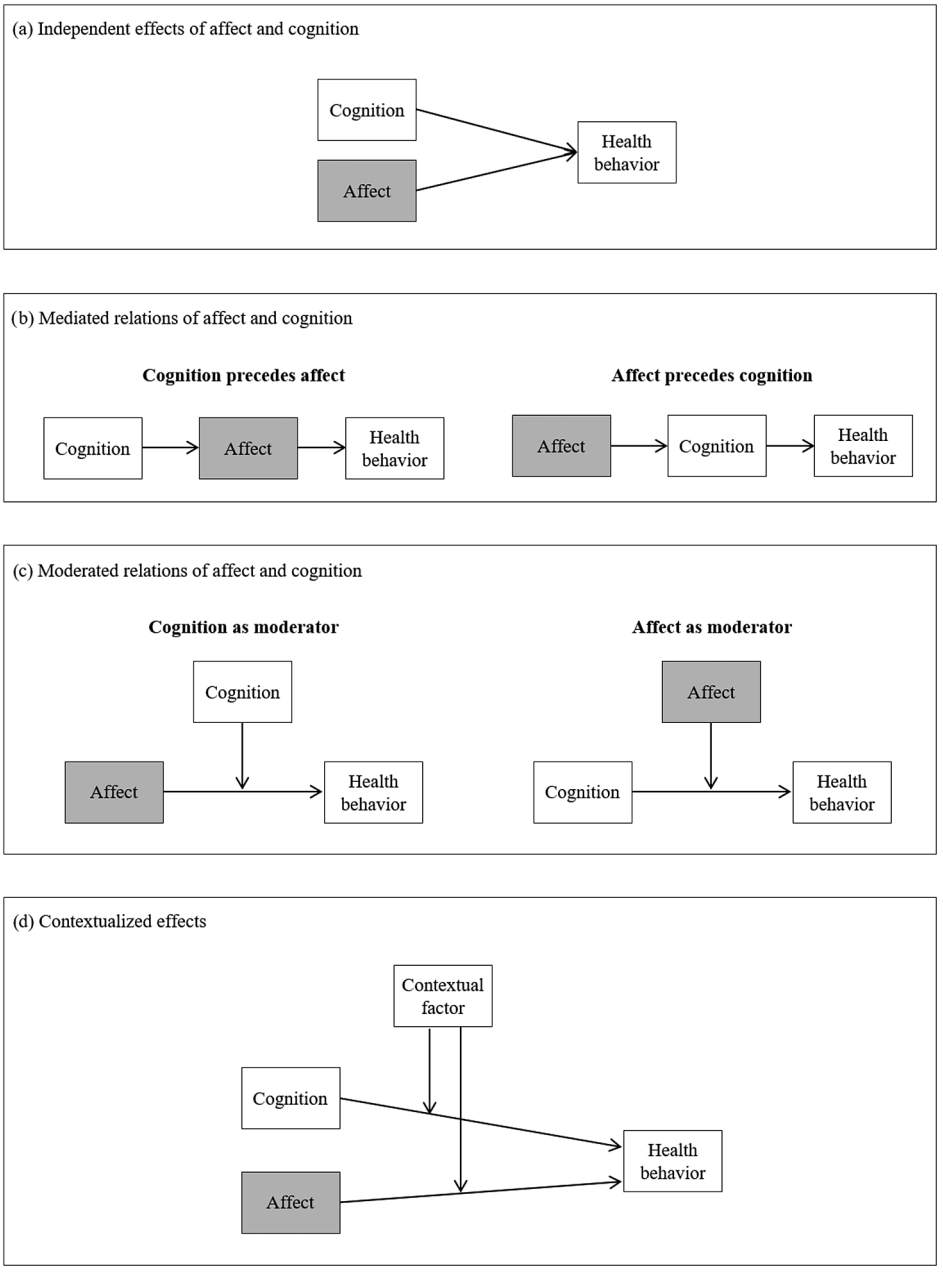

Figure 1. Types of relations between affective and cognitive constructs.

Considering only main effects unnecessarily limits our understanding of the complex and intersecting ways in which thoughts and feelings influence health behaviours. Broadening our theorising to consider a wider range of both theoretically

and statistically plausible mechanisms for the intersection of cognition and affect as influences on behaviour has great merit for both our scientific goal of understanding and explaining health behaviour and our public health goal of effectively intervening to encourage healthier behavioural practices.

Framework for considering the affect-cognition interplay

In the following sections of the paper, we consider several important complex relations between cognition and affect in detail. We first examine mediated relations, addressing both affect and cognition serving as mediators of the other's relation to health behaviour (i.e. affect mediating a cognition-behaviour relation or cognition mediating an affect-behaviour relation). Next, we examine relations where either affect or cognition moderates the other's effect on health behaviour. Finally, we examine two additional complexities – context as an influence on the interplay of affect and cognition and situations where affect and cognition may not be separable constructs (see Figure 1). Notably, the types of relations considered in this framework are not mutually exclusive. Given the complexity of human behaviour and the multiple influences on behavioural regulation, it is plausible that multiple types of relations could be involved in determining engagement in a particular health behaviour.

Mediation

A plausible type of complex interplay between cognition and affect is serial mediation, in which one construct's influence on behaviour is more distal/indirect and mediated by the other construct. Two basic possible types of mediation models are 1) *affect preceding cognition models,* in which cognition mediates the association between affect and health behaviour and 2) *cognitions preceding affect models,* in which affect mediates the relation between cognitions and health behaviour (see Figure 1(b)). The literature contains empirical support for both models, and we believe that the two are not mutually exclusive.

Affect preceding cognition model

Several theorists have argued that individuals may develop their cognitions towards health behaviours based on their initial affective reactions–an *affect preceding cognition* model. The affective heuristic, developed by Paul Slovic and colleagues, suggests that risk perception guides behaviour through a process in which individuals first rely on their 'gut level' affective feelings of risk. Following this 'gut level' response, those affective feelings then shape their cognitive perceptions of risk (e.g. 'I'm feeling scared when I consider this hazard, so I must be at high risk for experiencing it'; Slovic, Finucane, Peters, & MacGregor, 2002, 2004). An experiment examining vaccination behaviour provides empirical support for this type of mediational model, finding that fear increased perceived severity (a health cognition), which in turn increased willingness to get vaccinated (Moss, Gilkey, McRee, Reiter, & Brewer, 2016). Further supporting this model are two studies finding that graphic cigarette pack warnings increased negative affective reactions that subsequently were associated with cognitions

and outcomes, including risk perceptions and quit intentions (Emery, Romer, Sheerin, Jamieson, & Peters, 2014; Evans et al., 2015).

Cognition preceding affect model

Other models illustrate how cognition might precede affect. Kiviniemi et al. (2007) proposed a behavioural affective associations model in which cognitions generate affective reactions that then motivate behaviour. In addition to positing that affect mediates the relation between cognitions and behaviour, the model proposes that affect can also guide behaviour independent of cognitions. Empirical support for this model includes cross-sectional studies of physical activity (Kiviniemi et al., 2007), fruit and vegetable consumption (Kiviniemi & Duangdao, 2009) and screening behaviours (Brown-Kramer & Kiviniemi, 2015; Kiviniemi, Jandorf, & Erwin, 2014).

Supporting both the specified mediational models and the causal relations between affect and behaviour, experimental manipulations of affective associations lead to changes in subsequent health behaviours, and they do so without any accompanying changes in cognitive beliefs (Ellis, Homish, Parks, Collins, & Kiviniemi, 2015; Walsh & Kiviniemi, 2014). This experimental evidence supports the cognition preceding affect model (where affect is the more immediate/direct guide to behaviour) but is inconsistent with the affect preceding cognition model.

More recently, Keer, van den Putte, and Neijens (2012) concluded that affective evaluation of health behaviours partially mediated the influence of attitudes and perceived behavioural control on intentions. Similar mediational paths have been shown for the relation of cognitive and affective components of risk and sunscreen use (Kiviniemi & Ellis, 2014), cervical cancer screening (Zhao & Nan, 2016), and vaccination (Chapman & Coups, 2006).

Implications

These mediational models suggest that understanding both the origins and operation of both cognitive and affective influences on behaviour necessitates consideration of the temporal order of affect and cognition. In the affect preceding cognition models, affect serves an informational role, guiding the content and valence of subsequent cognitions (Schwarz & Clore, 1983). By contrast, the cognition preceding affect models focus on affect in a signaling role (Oya et al., 2005; Peters, Lipkus, & Diefenbach, 2006); affective associations with behaviours signal the 'appropriateness' of engaging in the behaviour, with more positive affective associations signaling a motivation to engage in the behaviour and more negative associations signaling a desire to avoid engagement.

The available theoretical support and empirical evidence for both temporal relations also underscores the need to test both models, especially when theorising about mechanisms for behaviour change, as the mechanisms suggested by each type of model are quite different. Finally, this difference in models supports the need for longitudinal studies and experimental studies (e.g. Ellis et al., 2015; Moss et al., 2016; Walsh & Kiviniemi, 2014), which provide stronger evidence for mediational pathways than cross-sectional studies (MacKinnon, Fairchild, & Fritz, 2007). In the end, it is likely that both models are useful and we need to identify the specific circumstances that determine under what conditions each model best functions.

Moderation

The strength and direction of the relation between cognitions and health behaviour can vary depending on the feelings associated with the behaviour, and the strength and direction of the relation between affect and health behaviour may likewise depend on cognition (see Figure 1(c)). Although statistically these two statements are equivalent (each would be modelled by a cognition by affect interaction term with behaviour as the outcome), the distinction is conceptually meaningful. Consideration of moderating mechanisms typically involves hypotheses where one construct has a direct causal influence (i.e. the hypothesised mechanism for regulation of the behaviour), and another construct is a moderating influence on that mechanism. Thus, hypothesising that affect moderates a cognitive mechanism makes different assumptions about the nature of behaviour regulation than does hypothesising that cognition moderates an affective mechanism, even though the two are statistically equivalent.

Affect, such as anticipatory worry, can moderate the relation between cognitions and health behaviours. Several studies show that high levels of worry may attenuate the beneficial effects of other cognitions on health behaviour and ultimately reduce engagement in those behaviours (Ferrer, Bergman, & Klein, 2013; Ferrer, Portnoy, & Klein, 2013; Klein, Zajac, & Monin, 2009). For instance, findings from cross-sectional national surveys suggest that worry about cancer moderates the association between cognitively-based risk perceptions and health behaviours. Among people with low levels of worry about cancer, cognitive risk perception (perceived likelihood) was not associated with fruit and vegetable intake and exercise; among people who worried a lot, higher perceived likelihood of cancer was associated with less engagement in the behaviour (Ferrer et al., 2013). Similarly, high levels of worry weakened the associations between cognitions such as self-efficacy and perceived benefits of fruits and vegetables and the motivation to purchase them (Ferrer et al., 2013), and high levels of worry led to a negative association between cognitive risk perceptions and intentions to quit among adult smokers in a longitudinal study (Klein et al., 2009).

Perceived risk can also moderate the association between worry and health behaviour. Among patients with diabetes, cognitive risk perceptions about heart disease moderated the association between worry and intentions to exercise such that the relation between worry and intentions was stronger for participants with higher cognitive perceived risk than those with lower perceived risk (Portnoy, Kaufman, Klein, Doyle, & de Groot, 2014). In another study, cancer worry was associated with avoiding doctors only when cognitive perceived risk of cancer was also high (Persoskie, Ferrer, & Klein, 2014). These findings suggest that affect, cognition *and* their interaction can influence health behaviours. Studying only main effects may lead to erroneous conclusions about when and for whom each construct is associated with behaviour.

Implications

Experimental evidence suggests that affective components of health messages may influence overall message effectiveness and moderate the relation of cognitions and health behaviour. Increasing the affective content of health messages by including affect-eliciting elements or delivering the information in narrative or testimonial format can enhance message effectiveness and elicit stronger effects on targeted behavioural

outcomes (Berns, Laibson, & Loewenstein, 2007; Keer, van den Putte, de Wit, & Neijens, 2013; Keer, van den Putte, Neijens, & de Wit, 2013). In a study aimed at increasing colorectal cancer screening, messages framed in terms of what could be gained by screening were less effective at increasing behavioural intentions compared to messages framed in terms of what could be lost by not screening, unless they were also paired with a complementary 'affective booster' that asked individuals to vividly imagine how they would feel if they got screened (Ferrer, Klein, Zajac, Land, & Ling, 2012). This affective booster increased the effectiveness of the gain-framed messages to be comparable to that of the loss-framed messages. These findings suggest that careful consideration of the way in which affect moderates other messaging components can allow for a more nuanced understanding of the specific motivational messages (Ferrer et al., 2012), contexts, and framing (Berns et al., 2007) needed to be effective for specific population subgroups.

Contextualised effects

The role of affect and cognition in shaping health behaviour may depend on contextual factors. Here, we consider five possible contextual influences on the role of affect and cognition on behaviour: the behaviour itself, other social-cognitive factors, culture, the nature of the affective construct, and the type of outcome variable (see Figure 1(d)). Most of this work has centered on how these factors shape the main effects of cognition and affect rather than their interplay.

First, the size of the effects of affect and cognition on behaviour may depend on the type of health behaviour. Theorists have conceptualised attitudes as having cognitive and affective components that represent beliefs and feelings respectively about the attitude object (Breckler, 1984). Affective attitudes are weak predictors of vitamin use and tooth brushing, and strong predictors of fruit and vegetable consumption, alcohol use, smoking, and exercise (Lawton et al., 2009). For example, beliefs that exercise is enjoyable, pleasant, or fun (positive affective attitudes) are stronger predictors of behaviour than beliefs about the health benefits of exercising (Conner, Rhodes, Morris, McEachan, & Lawton, 2011; Lowe, Eves, & Carroll, 2002; Rhodes, Fiala, & Conner, 2009). Risk perceptions may have distinct cognitive and affective components (Ferrer, Klein, Persokie, Avishai-Yitshak, & Sheeran, 2016) and the magnitude and relation of each component to health behaviour depends on the disease context and prior experience with the behaviour (Caffray & Schneider, 2000; Chapman & Coups, 2006; Schmiege, Bryan, & Klein, 2009; Shiloh, Wade, Roberts, Alford, & Biesecker, 2013). For instance, individuals who are actively engaged in a health protective behaviour, such as cancer screening, often have the highest levels of worry and perceived risk about the health threat (e.g. Hay, Coups, & Ford, 2006), whereas those not considering protective behaviours have the lowest values of perceived risk and worry (Brenes & Paskett, 2000). Relatedly, the amount of experience with risky health behaviours (e.g. having sex, cigarette smoking) influences the nature of adolescents' affectively based goals for engaging in the behaviour (Caffray & Schneider, 2000). Behaviours may also differ in the type of feelings they elicit. For instance, evidence suggests smoking behaviour is most strongly associated with anticipated regret, whereas sunscreen use is influenced by cognitive and affective risk beliefs (Janssen, Waters, van Osch, Lechner, & de Vries,

2014). These differences in the magnitude, type, and relative importance of affective and cognitive predictors may have consequential effects on the behaviour under study.

Second, other social cognitive constructs may also determine the influence of affect relative to cognition on health behaviour. The influence of affective factors tends to increase when people experience ambivalence or when affective and cognitive influences diverge (Lavine, Thomsen, Zanna, & Borgida, 1998; Lawton et al., 2009). This tendency may help explain why people engage in risky behaviours that are perceived as enjoyable but unwise (Loewenstein, Weber, Hsee, & Welch, 2001). Affective factors are also more influential than cognitive factors when cognitive resources are depleted, such as when people are tired or hungry (Hofmann, De Houwer, Perugini, Baeyens, & Crombez, 2010; Hofmann, Friese, & Roefs, 2009). For instance, greater impulsivity is associated with a stronger effect of implicit affect relative to implicit cognition on food choices (Trendel & Werle, 2016). Research on intertemporal choice and impulsivity shows that affective factors can drive seeking of short-term gains, whereas cognitive factors help one focus on more long-term gains (Loewenstein, 1996; Metcalfe & Mischel, 1999). Interestingly, the perceived passage of time varies considerably depending on one's emotional state. Boredom, depression, and anxiety have all been associated with perceived slowing of time and overestimation of duration (Wittmann & Paulus, 2008). Thus, there may be a complex interplay between affective processes and intertemporal choice as predictors of health behaviours. Similarly, greater need for affect, defined as a motivation to approach emotion-inducing situations (Maio & Esses, 2001), increases the relative influence of affective factors on behaviour (Conner et al., 2011; Figner, Mackinlay, Wilkening, & Weber, 2009; Huskinson & Haddock, 2004). Conversely, dispositional tendencies to avoid affect are associated with stronger associations between cognitive predictors, such as deliberative risk perceptions and behavioural intentions (Ferrer, Klein, Persoskie, Avishai-Yitshak, & Sheeran, 2016).

Third, culture may affect the roles of affect and cognition. Cultural differences exist in the ways that social and contextual factors shape food-related affect (Luomala, Sirieix, & Tahir, 2009), as well as in the relative influence of affect and cognition on eating behaviour (Cervellon & Dube, 2002, 2005; Luomala et al., 2009). For instance, affective influences (e.g. sensory and pleasurable attributes) and cognitive beliefs (e.g. healthfulness) about food show greater consistency in China than in the United States or France (Cervellon & Dube, 2002). Perhaps as a result, in the United States affective factors more strongly guide food choices than do cognitive factors (Kiviniemi & Duangdao, 2009), whereas in China, cognitive and affective factors have more equal influence (Cervellon & Dubé, 2005). As another example, there are cultural differences in ideal affect – the feelings one would prefer to feel. Whereas European American adults prefer high arousal, positive affective states like excitement and elation, Chinese and Chinese American adults prefer low arousal, positive affective states like calm and peaceful (Tsai, Knutson, & Fung, 2006). These differences in ideal affect in turn influence behaviours – individuals select behaviours that they believe will elicit their ideal affective states, which leads European Americans to be more likely to engage in high arousal leisure activities like running (Tsai, 2007). With respect to culture and cognitive decision-making influences, Chinese adults engage in greater temporal discounting (placing less value on more distal outcomes) for potential gains than do American adults (Gong, Krantz, & Weber, 2014). Chinese adults also use relatively more rule-based decision-making processes (Weber, Ames, & Blais, 2005).

Fourth, the affect and cognition specific constructs studied are likely to influence the strength of associations with health behaviour. Researchers have made several distinctions between different types of affect (DeSteno et al., 2013), and the affect-cognition interplay and relation to behaviour may depend on the type of affect under consideration (Ivings & Khardaji, 2007; Trendel & Werle, 2016). Studies suggest anticipated emotions are more strongly predictive of behaviour than are experienced emotions (Dunton & Vaughan, 2008; Ferrer et al., 2015) and affective attitudes (White, Horwath, & Conner, 2013). In another study, anticipated regret and worry both mediated the effects of perceived risk on influenza vaccination, but they influenced subsequent vaccination decisions differently (Chapman & Coups, 2006). Likewise, the Appraisal Tendency Framework suggests the decisional and behavioural effects of discrete emotions (e.g. anger, sadness) depend on appraisal tendencies, which vary across discrete emotions of the same valence. Anger is associated with action orientations and greater risk propensity. By contrast, fear is instead associated with an avoidance orientation and motivation to mitigate risk (Ferrer, Klein, Lerner, Reyna, & Keltner, 2015; Lerner & Keltner, 2000). Moreover, effects of self-control and other moderators of the affect-behaviour relation depend on whether affect is explicit or implicit (Ellis, Collins, Homish, Parks, & Kiviniemi, 2016; Trendel & Werle, 2016). Effects also depend on whether affect reflects self-conscious (e.g. regret, guilt) or hedonic emotions (e.g. enjoyment, excitement; Giner-Sorolla, 2001).

Although the primary focus of this paper is on actual behavioural engagement as the outcome variable, a final contextual factor, the type of outcome measure, should be acknowledged. In many studies, both affective and cognitive attitudes are associated with behavioural intentions, but affective attitudes also have direct effects on actual behaviours independent of behavioural intentions (Chae & Lee, in press; DeSteno et al., 2013; Lawton et al., 2009). Therefore, studies that use behavioural outcomes (rather than intentions) may find stronger associations with affect than with cognition.

Implications

Identifying how context shapes the relative importance of affect and cognition may be particularly important when interventions can be tailored to account for contextual elements (e.g. Ferrer et al., 2012; Shiv & Fedorikhin, 1999). For instance, studies suggest health messages that emphasise affective information (e.g. 'Physical activity can make you feel cheerful') can increase the influence of affect and thus elicit greater health behaviour change than cognitively based messages (Conner et al., 2011; Dillard, Fagerlin, Cin, Zikmund-Fisher, & Ubel, 2010; Fabrigar & Petty, 1999; Janssen, van Osch, de Vries, & Lechner, 2013; Janssen, van Osch, Lechner, & de Vries, 2015). However, individual characteristics may moderate affective messages' effectiveness. For physical activity interventions, affective messages were particularly influential among participants with higher need for affect (Conner et al., 2011) and low levels of baseline activity (Sirriyeh, Lawton, & Ward, 2010).

Exploring how context shapes the interplay between affect and cognition remains an important research area. Doing so may identify conditions under which affect more strongly mediates or moderates the relation of cognition and behaviour, or vice versa. This focus on the influence of context has the potential to further our understanding of the mechanisms involved in the interplay of affect and cognition as influences on behaviour.

When affect and cognition mix

To this point, our analysis has considered thoughts and feelings as separate constructs. However, several important constructs that motivate health behaviour may blend cognition and affect to some extent. Indeed, the distinction between affect and cognition may be an artificial one, at least at the neural level (Cacioppo & Berntson, 2007; Davidson, 2003; Duncan & Barrett, 2007; Eder, Hommel, & De Houwer, 2007; Phelps, 2005). Loewenstein and colleagues (2001) draw a distinction between *anticipatory affect*, actually experiencing a feeling when considering a behavioural action or health risk (e.g. thinking about a colonoscopy and feeling disgust), and *anticipated affect*, having the expectancy that one will experience an emotion if one engages in a behaviour (e.g. expecting to be embarrassed if one suggests that a partner use a condom).

With respect to anticipatory affect, consider worry associated with health behaviours, including screening for breast cancer (Hay, McCaul, & Magnan, 2006). Worry can be thought of as an affective process (a bad feeling of concern) or an affect-laden cognitive process (perseverating on the future, turning things over in one's mind in an obsessive way that results in negative affect). Both conceptualisations link affect and cognition and involve affect occurring because of cognitions about a health problem or behavioural outcome. With respect to anticipated affect, consider anticipated regret – a potent motivator of health behaviour that can be stronger than other types of anticipated affect (Brewer, DeFrank, & Gilkey, 2016). Anticipating regret of not vaccinating should motivate getting vaccinated as people seek to avoid feeling regret in the future. The anticipation is a largely cognitive event, but the act of envisioning future affect likely entails some experience of the emotion in the present.

Reactance is a third example of a construct in which affect and cognitions are intertwined. In reactance, people who perceive a threat to freedom react with anger and act to discredit the threat (Dillard & Shen, 2005; Hall et al., 2016). Although reactance involves distinct affective and cognitive dimensions (anger, perceived threat to freedom, counterarguing), these dimensions are typically highly correlated. Some studies have shown that reactance undermines motivation to quit smoking (e.g. Hall et al., 2016), but studies have not yet examined the impact of reactance on actual smoking or other health behaviours.

The important observation about each of these 'mixed' constructs is that the literature treats them as simple, unidimensional entities, even though each mixes affect and cognition to some extent. Barrett has warned that research based on emotion words and categories such as anger or fear may not get to the heart of the matter, and may instead create artificial affect categories unrelated to the underlying biology and neuroscience (Barrett, 2006). Thus, we may need to be cautious when considering models that treat thoughts and feelings as distinct phenomena. In at least some cases, the two may be intertwined and inseparable.

Discussion

The purpose of this paper is to provide a framework for different types of relations between cognitive and affective influences that should be considered when theorising about their possible effects on health behaviour and for the development of intervention approaches to change people's health behaviours. We contend that the respective roles

of affect and cognition in health decision-making have been studied largely through a main effects lens, masking the many nuanced ways in which affect and cognition interrelate in driving health behaviour.

In particular, our framework addresses moderating and mediating roles of affect, and the interplay between cognitive and affective influences. Affective experiences such as worry and fear can both precede and follow cognitions such as attitudes, with potentially important implications for behaviour. Moreover, affect and cognition can each moderate effects of the other – an important point given issues of interpreting main effects when interactions are present. Contextual factors can also shape and change the interrelation of affect and cognition. Finally, affect and cognition can be blended in constructs such as reactance, highlighting perhaps even more the importance of examining the complexity of their effects.

Because our framework is focused on the interplay of affect and cognition as motivators of health behaviour, it does not touch upon the role of affect in shaping information processing (Peters et al., 2006). First, affect provides information. People may consult their emotions, associated with certain choices and developed through experience, to make a decision. Second, affect can act as a spotlight, drawing attention to particular information. How strongly we feel about an object may make salient different types of information (i.e. benefits or risks). Additionally, we do not address the possibility that affect may act as a confounding third variable that confounds the relation between motivation and actual behaviour.

Implications for studying health behaviour

The shift in focus towards considering the complex interplay between affect and cognition has several implications for conducting health behaviour research as well as developing theoretical models for understanding behavioural regulation. One key implication is that researchers should routinely examine the types of complex relations that we describe herein. Although such an approach can increase the numbers of tests and therefore family-wise error, this concern is outweighed by the countervailing concern that main-effects only models underspecify the 'real' underlying complexity in behaviour. As long as such tests are considered and reported as *post hoc* rather than *a priori* predictions, exploring them can add value even if the original theoretical model did not include moderating and mediating influences.

Even better than *post hoc* inclusion would be including complex relations in *a priori* theorising and hypothesis generation. We would strongly suggest that such relations be thoughtfully considered in theory development. In the context of moderating and mediating mechanisms, both types of relations lead to different hypotheses and different implications about the kinds of mechanisms through which cognitive and affective influences drive health behaviour, as well as explanations about the motivations driving individuals to engage in behaviour, and the nature of the interplay between affect and cognition. Considering these influences conceptually when developing theories and 'pushing the envelope' of our thinking about influences on behaviour can only strengthen the creativity and potential utility of our theories (for related perspectives on pushing the thinking envelope, see McGuire, 1997, 2004).

Finally, if indeed the interplay between affect and cognition drives health behaviour, it is crucial to understand how to manipulate each independent of the other in order to

obtain relatively pure estimates of the effect of each, and their interaction. Although one meta-analysis reviewed studies that have unwittingly observed changes in one and not the other (i.e. worry but not risk perception, Portnoy, Ferrer, Bergman, & Klein, 2014), we are not aware of any published research that attempts to manipulate each construct independently. Likewise, future research will need to consider how one might examine multiple affective and cognitive constructs in a particular setting. For parsimony, our paper has focused on rather simple interactions or temporal relations between one type of affect (e.g. fear) and one type of cognition (e.g. beliefs), but it is obvious that the real state of affairs is more complex. For example, fear about having a genetic marker for disease may influence attitudes about getting a genetic test, but only if one believes that similar others are doing so (Reid et al., manuscript under review). To the extent that we understand this complex interplay, we can explain more variance in health behaviour.

Implications for interventions

Many interventions seek to change either cognition or affect in order to encourage a health behaviour. Naturally, an understanding of how affect and cognition interrelate could increase the efficacy and reach of such interventions. For example, the use of graphic warnings is an example of a policy-level intervention that uses images to enhance health messages with negative affect. Graphic warnings have been shown to increase knowledge, negative affect, and smoking cessation (Brewer et al., 2016; Noar et al., 2016). However, the focus on affect might leave relatively unaddressed potentially synergistic routes targeting cognitive processes. By the same token, interventions designed solely to change cognitions such as beliefs and self-efficacy might be more effective to the extent that they consider and incorporate affect.

Over and above simply considering both cognitive and affective processes in intervention design, developers of intervention techniques should consider the various types of more complex relations outlined in our framework. For example, if behaviour change is driven by the interaction between cognition and affect, an interventionist should either develop techniques to change both constructs or to pre-screen participants to ensure that their standing on the moderating construct is of a nature to ensure that the targeted mechanism leads to a change in behaviour. Similar issues would be involved in addressing many of the contextualised mechanisms discussed above.

Mediational relations also need to be considered in intervention development. If an intervention technique targets the more distal, indirect causal mechanism in a mediational chain, an important determinant of intervention effectiveness will be the strength of the relation between the targeted construct and the mediator, as well as the strength of the relation between the mediator and the behaviour. The ‘dose’ or strength of the intervention technique will need to be sufficient to lead to a meaningful change in the behaviour given the strength of each of the linkages along the mediational chain.

When an intervention targets the intervening/mediating variable in the chain, the strength of the relations in the full mediational model is less of a concern, but the interventionist has a choice to consider. One option would be to simply target the mediator, but another option is to create conjoint interventions that seek to address both the distal and the proximal/mediating variable. To our knowledge, such approaches have not been developed and would require empirical testing, but should be considered given the nature of the more complex causal associations involved in the mediational models.

Concluding thoughts

Our paper highlights four ways in which affect and cognition can influence health behaviour in ways that integrate the two classes of constructs rather than simply assessing their independent effects. In other approaches to understanding decision-making and health behaviour, many dual-processing models have emerged that posit independent streams such as 'hot' and 'cold' cognition and 'system 1' and 'system 2' thinking (Chaiken & Trope, 1999). These models do not necessarily provide a foundation for understanding how the dual processes interact and influence each other. Consequently, pursuing the interrelations of affect and cognition in determining health behaviour may also provide a working model for how to investigate other types of dual processes such as implicit and explicit cognition. Moreover, research like that proposed here goes beyond the debate of whether affect precedes cognition or vice versa (Zajonc, 1980, 1984) and instead considers that both temporal models are possible and have distinct, meaningful implications for behaviour.

We also wish to emphasise that the research for which we advocate can simultaneously advance basic understanding of human behaviour and address real-world health issues consistent with the vision of *Pasteur's Quadrant* (Stokes, 1997). Many of the leading causes of death around the world are attributable to a short list of behaviours that includes tobacco use, sedentary behaviour, poor diet, and alcohol abuse (Mokdad, Marks, Stroup, & Gerberding, 2004). These health behaviours have been shown to follow affective states such as craving and cognitions such as risk perceptions. To the extent that we understand how we might integrate these affective states and cognitive influences into a more nuanced model of health behaviour, we can achieve the concomitant public health goals of reducing mortality and enriching our theories and scientific understanding (Klein, Shepperd, Suls, Rothman, & Croyle, 2015).

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