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Protection motivation theory and health behaviour: conceptual review, discussion of limitations, and recommendations for best practice and future research

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ABSTRACT

Protection motivation theory is a pre-eminent health behaviour theory purposed to predict participation in health protection and risk behaviours. It has been widely applied across multiple behaviours, populations and contexts. In this conceptual review, we summarise research applying the theory and identify shortcomings and evidence gaps that limit reported inferences and impede theory and intervention development. Accordingly, we provide recommendations for best practices and suggestions for future research to resolve these limitations. Limitations identified include a dearth of comprehensive theory tests, sparse evidence of theory sufficiency, a lack of studies including additional constructs, overuse of correlational and cross-sectional research designs, a paucity of intervention studies and tests of theory-consistent mechanisms of action, few tests intrapersonal and environmental moderators of theory effects and measurement concerns. We provide recommendations to address these limitations including conducting comprehensive theory tests in support of nomological validity; incorporating past behaviour and other constructs to establish theory sufficiency and extend its scope; adopting cross-lagged panel and factorial experimental research designs to test directional effects, permit better causal inference and test mechanisms of action; testing effects of moderators to identify conditions that may affect theory applicability and developing measurement standards for study constructs and adopting non-self-report behaviour measures.

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Epidemiological research has indicated that regular participation in health-promoting behaviours (e.g., adhering to health screening, regular physical activity participation, following a healthy diet), and long-term cessation, moderation, or avoidance of behaviours that present a risk to health (e.g., limiting sedentary activity, avoiding excessive alcohol consumption, abstinence from smoking tobacco), is consistently related to positive physical and mental health (Ford et al., 2011; Shaw & Agahi, 2012; Warren Andersen et al., 2018). However, population level rates of participation in these health-related behaviours in many countries are insufficient to confer these stipulated health benefits (Bruni et al., 2022; Centers for Disease Control and Prevention, 2021b; Haug et al., 2009), while participation rates for risk behaviours remain at levels likely to pose ongoing threats

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to health (Centers for Disease Control and Prevention, 2021a; Shmulewitz et al., 2021; Silveira et al., 2022). Governmental and community health organisations have, therefore, formally designated promotion of health behaviours and prevention of risk behaviours through intervention a priority (Centers for Disease Control and Prevention, 2022; Spring et al., 2013; World Health Organization, 2021).

Accordingly, these organisations have identified the development and promulgation of behaviour change interventions aimed at fostering uptake and maintenance of health behaviours and cessation of risk behaviours as a key means to address this priority, particularly in at-risk populations. Such interventions are more likely to be optimally efficacious in changing behaviour if they are based on theoretical approaches that offer insight into the reliable determinants of health promoting and health risk behaviours and the processes involved (Bishop et al., 2015; Michie, 2008; Protogerou & Johnson, 2014; Rothman, Simpson, et al., 2020; Webb et al., 2010). In particular, researchers have applied theories from the behavioural sciences, particularly psychology, to identify these determinants and processes, as well as potential moderators that may explain contextual variations in determinant effects on behaviour (Hagger et al., 2020a; Johnston et al., 2021; Rothman, Klein, et al., 2020). Knowledge of determinant-behaviour links, and the linked processes and moderators, could highlight potentially modifiable targets for behavioural interventions aimed at promoting behaviour change. Further, these links may also inform work on the methods or techniques that may be efficacious in changing or activating these determinants and the mechanisms of action by which the techniques lead to behavioural enactment (Carey et al., 2018; Connell et al., 2019; Hagger et al., 2020; Sheeran et al., 2016, 2023). These techniques can then form the content of behaviour change interventions for dissemination to targeted populations by various means (e.g., messages highlighting risks, prompts to set goals, provision of feedback on progress, exercises specifying adoption and practice of self-regulatory skills; Dombrowski et al., 2016; Hagger & Hardcastle, 2014).

Theories adopting social cognition perspectives are pre-eminent among the theories that have been applied to identify the determinants of health and risk behaviours, and the relevant processes involved (Conner & Norman, 2015). Common to these theories is the assumption that individuals' decisions to perform a given target behaviour in future are a function of their processing of social information, summarised in the beliefs they hold with respect their future performance of the behaviour (Ajzen, 1991; Conner & Norman, 2015). These beliefs are assumed to be fundamental sources of information that individuals use to form behavioural intentions, a key motivational precursor of the uptake and maintenance of behaviour (Armitage & Conner, 2000).

A prominent theory of this type is protection motivation theory (Rogers, 1975), a theory specifically purposed to identify the determinants of behaviours that confer health benefits or reduce health risk and the decisional processes involved. Central to the theory is protection motivation, a construct equivalent to behavioural intention, which is designated as the most proximal correlate of health protective behaviour. Accordingly, protection motivation is proposed to serve as a mediator of the effects of sets of beliefs or *appraisals* concerning health risks or threats, personal capacity to perform the given behaviour, and the perceived utility of the target behaviour on performance of the behaviour in future. The theory also specifies the role of other key factors likely to be implicated in individuals' decision to engage in health protective behaviours, such as maladaptive responses that may undermine protection motivation.

The theory has been widely applied in research studies to predict health behaviours across multiple populations and contexts (Norman et al., 2015; Orbell et al., 2020; Prentice-Dunn & Rogers, 1986), and meta-analytic syntheses of this research has provided generalised support for theory-stipulated relations among its constructs across multiple health behaviours (Floyd et al., 2000; Milne et al., 2000). This broad empirical support notwithstanding, a number of limitations in the research methods employed to test theory predictions, as well as boundary conditions in theory conceptualisation and specification, have been identified. These limitations and boundary conditions place caveats and restrictions on the interpretation and generalizability of many theory tests available

in the current literature, and potentially serve to hinder the progress of research adopting the theory to identify behavioural determinants and develop behaviour-change interventions in health contexts (e.g., Cismaru & Lavack, 2007; Milne et al., 2002; Weinstein, 2007). Accordingly, in the current conceptual review of applications of the theory we aim to identify these limitations and boundary conditions, outline how they delimit inferences and affect the quality of current research findings, and provide guidelines on potential alternative research methods and study designs, and conceptual modifications, that may contribute to resolving them. The current review has value in that it is expected to set the agenda for future researchers seeking to develop studies that will address these issues so as to improve the scope and quality of the evidence for theory predictions and extend inferences that can be drawn from research applying it in health behaviour contexts.

Protection motivation theory: overview and key hypotheses

Protection motivation theory was purposed to identify the determinants of behaviours aimed at managing or coping with health threats, with a focus on illustrating how fear appeals may impact cognitions and subsequent health behaviours (Rogers, 1975). The basic constructs and hypothesised effects of the theory are summarised in Figure 1. A central hypothesis of the theory is that an individual's protection motivation is the most proximal determinant of the performance of health behaviours aimed at managing, or offering 'protection' from, health threats. Protection motivation is a motivational construct indicating an individual's readiness to adopt or engage in a behavioural response to a given health threat or health-promoting opportunity akin to the intention construct specified in other social cognition theories (see Ajzen, 1991; Fishbein et al., 2001; Triandis, 1977). In the theory, protection motivation is proposed to be a function of two parallel sets of beliefs or appraisals with respect to health threats and behavioural means to manage them: threat appraisals and coping appraisals. Threat appraisals represent beliefs about risks or threats to health (e.g., beliefs about the health risks associated with continuing to smoke cigarettes), and encompass perceived severity and perceived susceptibility or vulnerability, and the extent to which the 'maladaptive response', that is, not performing the behaviour, is rewarding. Coping appraisals represent beliefs about the efficacy of the behaviour in promoting desirable health outcomes, known as response efficacy, and the perceived costs of performing the adaptive response, known as response costs. A subsequent revised version of the theory introduced self-efficacy from Bandura's (1986) social

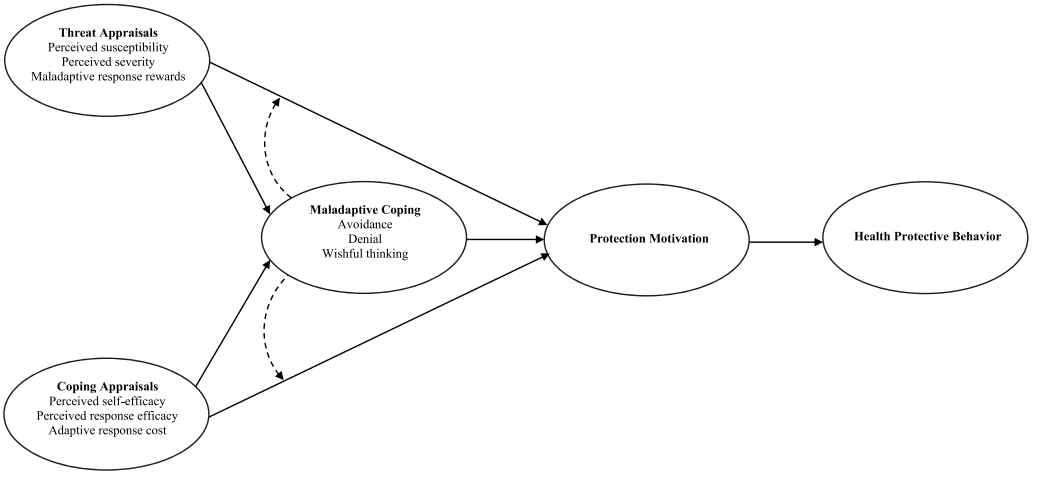

Figure 1. Protection motivation theory.

Note: Solid arrowed lines represent key theory predictions and broken lines represent moderation effects.

cognitive theory as an additional determinant of protection motivation (Maddux & Rogers, 1983). Self-efficacy reflects beliefs regarding personal capacity to perform the requisite behaviour.

Protection motivation serves a pivotal role in the theory as it is predicted to mediate relations between the social cognition constructs, namely, the sets of threat and coping appraisals and behaviour. The mediation effects indicate that individuals' appraisals and associated beliefs with respect to the target behaviour informs the intensity of their motivation to perform it in future and the extent to which they are subsequently prepared to pursue it (see Perugini, 2005). Threat and coping appraisals are also expected to be informed by individuals' processing of available interpersonal information about the behaviour derived from personal experience (e.g., past behaviour), and from environmental (e.g., social context, messaging) and intrapersonal (e.g., personality) sources.

In addition, threat and coping appraisals are hypothesised to affect individuals' adoption of alternate behavioural responses that run counter to effective threat management behaviours that would be expected to offer protection from the health threat. These maladaptive coping responses are typically adopted by individuals to cope with health threatening information, usually through mitigating the emotional upheaval caused by knowledge of the threat, but are not expected to ultimately lead to adaptive outcomes. Typically, such responses encompass coping procedures such as distraction, emotion suppression, avoidance, and denial, all of which generally tend to be focused on reducing felt negative emotions associated with the threat response (for a discussion see Carver et al., 1989). Given such responses tend to be alternatives to behaviours aimed at promoting adaptive health outcomes, they are expected to be negatively associated with protection motivation. Such a relationship likely reflects individuals prioritising the mitigation of the psychological distress associated with the threat because that is seen as more proximally valuable relative to the adoption of protective behaviours aimed at managing the threat, hence the maladaptive label.

The predicted associations between the theory constructs and protection motivation have been hypothesised to occur through multiple mechanisms. Specifically, associations between threat and coping appraisals and behaviours are proposed to be mediated by maladaptive coping as well as protection motivation, and effects of these appraisals on protection motivation are proposed to be moderated by maladaptive coping. The mediated effects reflect the tendency for individuals to respond to high perceptions of threat with emotion-focused coping strategies like avoidance or denial, which are proposed to be negatively related to protection motivation for the adaptive health behaviour. The moderation effects suggests that effects of threat and coping appraisals on protection motivation and behaviour are likely to be undermined among those who tend to adopt maladaptive coping strategies relative to those who do not engage in such behaviours.

Hundreds of studies have applied protection motivation theory to predict multiple health behaviours in numerous contexts and populations (e.g., Babazadeh et al., 2017; Guo et al., 2015; Helmes, 2002; Norman et al., 2015; Taylor & May, 1996). Large-sample tests of the theory, often assumed to produce the most reliable estimates of effects, have supported the key hypothesised effects of the theory in behavioural contexts such as physical activity (Plotnikoff et al., 2009, 2010), healthy eating (Chamroonsawasdi et al., 2021), and vaccination (Li & Sun, 2021; Wu et al., 2022), and highlighted its potential value in identifying key behavioural correlates and the processes involved. Similarly, meta-analytic syntheses of this research have broadly corroborated key theory-implied associations among the appraisal constructs, protection motivation, and the coping and behavioural outcomes across studies, and indicate that the theory constructs individually explain substantive variance in protection motivation and health behaviour across contexts, behaviours, and populations (Floyd et al., 2000; Milne et al., 2000). For example, both meta-analyses demonstrated small-sized positive correlations between perceived susceptibility and severity, and between protection motivation and behaviour. Medium-sized negative correlations have also been observed between perceived response costs and protection motivation and behaviour, as well as positive correlations between self-efficacy, response efficacy, and protection motivation and behaviour with highly variable effect sizes, and suggest that associations of coping appraisals and protection motivation and behaviour tend to be larger than for threat appraisals. In addition, these analyses both highlighted the

paucity of research at the time examining maladaptive response rewards, maladaptive coping responses, response costs, and fear.

A key caveat of these meta-analytic findings is that they confine their analysis to zero-order or bivariate correlations among theory constructs. This is in contrast to primary studies that typically adopt multivariate analytic models and, therefore, provide more robust tests of theory predictions because they estimate the unique effects of each theory construct on protection motivation while simultaneously accounting for the effects of the other constructs (Floyd et al., 2000; Milne et al., 2000; Norman et al., 2015). As a consequence, a meta-analysis of research on the theory that adopts multivariate analytic techniques to estimate unique theory effects across the extant literature represents a key type of research that may fill this gap. This approach has been previously applied in meta-analyses of other social cognition theories such as the theories of planned behaviour (e.g., Hamilton et al., 2020; McEachan et al., 2011) and the reasoned action approach (e.g., Hagger et al., 2018; McEachan et al., 2016) and provides a template for procedures that could be usefully applied to research on protection motivation theory. We look to future research to conduct such an analysis, which will not only provide more precise estimates of the unique effects of theory constructs and their associated variability across the literature, but provide the opportunity to update the effects identified by Milne et al. (2000) and Floyd et al. (2000) as well as the opportunity to conduct more extensive moderator analyses.

Alongside research derived from correlational data, there has also been experimental and intervention studies adopting randomised controlled designs testing the efficacy of the theory in guiding efforts to change behaviour and promote adaptive outcomes in health contexts (e.g., Gong et al., 2009; Khiyali et al., 2017; Mccullock & Perrault, 2020). It is also important to note that research adopting these designs is more prevalent for protection motivation theory relative to other social cognition models (e.g., the theory of planned behaviour; Hagger, 2019). Such experiments and interventions adopt strategies or *techniques* that seek to change health behaviours through change in, or activation of, the salient constructs of the theory (e.g., messaging emphasising health risks targeting change in threat appraisals, educational videos highlighting effectiveness of the target behaviour targeting change in response efficacy, prompting successful practice targeting change in self-efficacy). Such research has additional value beyond the previously cited correlational research insofar as they enable evaluation of the extent to which techniques targeting change in specific theory-relevant constructs affect subsequent and concomitant change in behavioural outcomes. Such research permits inference of causal effects and change for theory effects which is contraindicated in research adopting correlational designs. Studies adopting experimental or intervention designs and targeting change in key constructs such as threat and coping appraisals have demonstrated efficacy in changing behaviour in multiple behavioural domains such as sunscreen use, condom use, and physical activity (e.g., Gaston & Prapavessis, 2014; Gong et al., 2009; McClendon & Prentice-Dunn, 2001).

Taken together, a substantive body of research has provided support for key predictions of protection motivation theory (Taylor & May, 1996; Wurtele & Maddux, 1987), and the theory has demonstrated efficacy in guiding interventions targeting behaviour change in numerous behavioural contexts (Fruin et al., 1992; Malmir et al., 2018; Prestwich et al., 2008). This generalised support notwithstanding, various shortcomings or limitations of research on the theory have been noted as well as some important boundary conditions of the theory itself. In the next sections, we expand on these limitations and boundary conditions and how they serve to narrow the scope of inferences that researchers can draw regarding theory efficacy and predictive validity and stymie the extent to which it can effectively guide intervention and be broadly generalisable. Alongside this, we set out alternative research designs and methodological innovations that could potentially resolve these issues. Importantly, we provide recommendations of the specific kinds of studies needed to effectively address these limitations and contribute towards the improvement of the predictive validity of the theory. These issues, including their respective resolutions and suggestions for future reading, are summarised in Table 1. Our review follows a similar approach to other conceptual

Table 1. List of limitations and issues in protection motivation theory research identified in the current review with suggested recommendations and further reading.

Limitation/issue	Recommendation	Further reading
1. Comprehensive theory tests are seldom performed.	Perform tests of the theory which encompass most or, preferably, all proposed constructs of the theory, with appropriate conceptual rationale, and their expected relationships in simultaneous tests to confirm nomological validity of the theory.	Hagger et al. (2017); Maddux and Rogers (1983); Wang et al. (2019)
2. Few studies measure maladaptive coping responses, with a paucity of tests of mediation and moderation effects involving maladaptive coping.	Maladaptive coping should be measured as standard when testing the theory, along with tests of both mediation and moderation effects involving this construct.	Brown et al. (2005); Ho (2000); Rippetoe and Rogers (1987)
3. Need for widespread examination of the interaction between threat and coping appraisals.	Routinely incorporate tests of these interaction effects in studies.	Cismaru and Lavack (2007); Pechmann et al. (2003); Rogers (1975)
4. Past behaviour is seldom included in tests of the theory to provide evidence for its sufficiency and capture other unmeasured constructs.	Include a measure of past behaviour as a predictor of all theory constructs to test theory sufficiency and effects of unmeasured constructs.	Ajzen (1991); Hodgkins and Orbell (1998); Ouellette and Wood (1998)
5. Few studies test effects of additional constructs not originally encompassed within the theory on protection motivation and behaviour.	Include additional constructs from other theories when testing theory effects such as affective and implicit attitude measures, again, with appropriate conceptual rationale, to increase scope of theory.	Ajzen (1991); Bryan et al. (1997); Millar (2011)
6. The majority of research testing protection motivation theory adopts correlational and cross-sectional study designs.	Adopt longitudinal panel, experimental, and intervention designs wherever possible to facilitate directional and causal inferences.	Hagger et al. (2020a, 2020b); Milne et al. (2000)
7. Current experimental and intervention research on the theory tends to target multiple constructs in single condition designs.	Utilize factorial experimental and intervention designs that isolate effects of individual behaviour change techniques allowing evaluation of the unique and interactive effects of each technique, and, potentially, intervention mechanisms of action.	Hagger et al. (2020); Orbell et al. (2020)
8. Current studies tend not to adopt longitudinal designs that allow for inference of directional effects.	Longitudinal, cross-lagged panel designs should be routinely adopted to examine direction and reciprocity in effects among theory constructs while controlling for stability.	Dorsey et al. (1999); Gollob and Reichardt (1987); Hagger and Hamilton (2023); Lindwall et al. (2011); Van der Velde and Van der Pligt (1991).
9. Little research on effects of candidate moderator variables on theory effects, such as individual difference constructs and socio-structural variables.	Conduct more systematic study of these types of moderators, including examples such as socio-economic status and personality traits, to support generalizability of theory effects.	Amireault et al. (2008); Brouwers and Sorrentino (1993)
10. Use of standardised measures of theory constructs are not always adopted.	Application of formal classification procedures to ensure standardised theory measures are developed and widely adopted.	Ajzen (1991); Ajzen and Fishbein (1980); Hagger and Chatzisarantis (2009); Starfelt Sutton and White (2016)
11. Salient beliefs of the target population regarding the health threat or behaviour are seldom used as a basis for development of theory construct measures.	Conduct open-ended, formative research with the target population to solicit beliefs and guide subsequent development of construct measures.	Ajzen (2002); Norman et al. (2015); Searle et al. (2000)
12. A majority of studies adopt self-report measures of behaviour.	Employ non-self-report measures of behaviour whenever possible (e.g., observation, other wearable devices), to reduce biases associated with self-report measures.	Gaston and Prapavessis (2014); Hall et al. (2018); Norman et al. (2015); Sheeran et al. (2017)

reviews in the health psychology domain (e.g., Hagger & Orbell, 2022; Swann et al., 2021) and those specific to protection motivation theory in other domains (e.g., Clubb & Hinkle, 2015; Westcott et al., 2017), in that we provide an overview of the theory and current literature informed by the available primary research and evidence reviews, comment on and critically analyse current work, and make recommendations to address the limitations or issues arising from the review.

Specifically, our review will highlight the need for (a) research addressing the paucity of comprehensive tests of theory, particularly tests of theory-stipulated interaction and mediation effects such as those concerning maladaptive coping and the interaction of threat and coping appraisals; (b) studies examining additional constructs and variables within tests of the theory, including past behaviour to account for theory sufficiency and implicit and affective variables; (c) studies that adopt intervention or experimental designs that adopt manipulations or techniques targeting change in theory constructs to test theory-aligned mechanisms of action; (d) research examining the temporal stability of theory constructs and their long term prediction; (e) studies that address the dearth of research examining moderators of theory-implied effects, including socio-structural factors and personality traits; and (f) research examining effects of measurement issues that moderate theory effects including conceptualisation of theory constructs, the need to solicit salient beliefs regarding the target behaviour in the population of interest, the essentiality of adopting conditional measures of threat appraisals, and the importance of using non-self-report measures of behaviour. We propose an agenda suggesting research needed to address these limitations, particularly research that adopts designs that expand the scope of the inferences that can be made regarding the theory predictions. We encourage researchers to ensure their theory tests are optimally inclusive through, for example, inclusion of, and control for, past behaviour in theory tests, adoption of longitudinal panel, factorial experimental, and intervention designs that afford more robust causal inferences and tests of mechanisms of action, testing of moderators that may account for observed differences in theory effects dependent on the population and context, and adoption of rigorous standards to systematize and improve measurement of theory constructs.

Addressing the limitations and boundary conditions of protection motivation theory

Comprehensive tests of the theory

Researchers testing the predictive validity of social cognition theories have tended to examine the fit of a proposed network of theory-stipulated relationships specified *a priori* with correlational cross-sectional or longitudinal data from studies in which theory constructs and behavioural outcomes have been measured on one or more occasions (Hagger et al., 2017). Such tests enable confirmation or rejection of the specified pattern of unique relations among theory constructs in a single simultaneous model test, particularly where constructs are likely to be intercorrelated. It also allows for additional analyses to be conducted to examine theory-implied processes, such as mediation effects.

In the context of protection motivation theory, however, studies have tended not to conduct full theory tests that encompass all constructs, the proposed relations among them, and the associated mediation and moderation effects. These include the mediating effect of protection motivation on relations between threat and coping appraisals and behavioural outcomes, or potential interaction effects such as the interaction between self-efficacy, an example of a coping appraisal, and threat appraisals on protection motivation. Instead, researchers have tended to confine their analyses to a core subset of theory constructs (i.e., perceived susceptibility, severity, self-efficacy, response efficacy, and response costs) and predictions applied in novel contexts (e.g., COVID-19 preventive behaviours; Okuhara et al., 2020), often neglecting other key constructs (e.g., fear, maladaptive coping responses, maladaptive response rewards; Milne et al., 2000) and failing to test key theory predictions. Or they have focused on examining whether the introduction of a few additional constructs accounts for additional variance in protection motivation or behaviour alongside subsets of

constructs from the original theory (e.g., subjective norm; Prasetyo et al., 2020), rather than conducting confirmatory tests of the complete theory including mechanisms tests (e.g., Wang et al., 2019). Such tests are important in order to provide robust verification of the nomological validity of a theory, that is, whether the network of effects proposed by the theory stands up as a reasonable representation of relations between measures of its component constructs (see Bagozzi, 1981; Hagger et al., 2017).[1]

While there is inherent value in applications of protection motivation theory in new contexts, behaviours, or populations, as well as developing the theory through inclusion of additional constructs alongside the core constructs, this must be set against a need for comprehensive tests of the theory to provide robust support for the hypothesised network of relationships among the constructs as proposed. Such tests are important as testing hypotheses in isolation and neglecting inclusion of constructs that represent fundamental theory processes, or testing effects of moderators on isolated effects, may mean that potential attenuation or mechanistic effects are missed. These 'misses' may result in researchers drawing misleading conclusions with respect to the pattern of effects in the theory. A solution to this issue lies in performing tests of the theory which encompass all the proposed constructs of the theory and test the expected effects among them simultaneously. Specifically, this would include the following: direct and interactive effects of constructs representing threat (e.g., perceived severity and susceptibility) and coping (e.g., self-efficacy, response costs, response efficacy) appraisals on protection motivation; effects of the threat and coping appraisals on constructs representing maladaptive coping (e.g., avoidance, denial, emotion venting); correlations between maladaptive coping and protection motivation; effects of protection motivation on the target behaviour; and effects of key socio-structural and environmental constructs on the sets of appraisal constructs when applicable. In short, researchers should consider, at the very least, measuring each of the key constructs from the theory and examining the pattern of effects simultaneously using multivariate analyses (e.g., path analysis, structural equation modelling) as proposed by Maddux and Rogers (1983).

Although previous research has seldom tested the nomological validity of the theory, there is precedent for these types of study. For example, Wang and colleagues (2019) applied the theory to predict health protective behaviours performed during travel. The authors included a complete set of measures of theory constructs and a prospective measure of the target behaviour and specified the theory-defined pattern of relations among them. Regression models provided support for the effects, including the mediation of appraisals and protective behaviours by protection motivation, and the negative effect of maladaptive coping on protection motivation. Although such tests are rare, they provide a template for future researchers to conduct 'bare minimum' tests of the theory using correlational designs.

A further noteworthy omission in tests of the theory is the paucity of tests of effects of maladaptive coping responses or strategies on protection motivation and behaviour. The lack of research testing these effects precluded their inclusion in a previous meta-analysis of the theory (Milne et al., 2000). In addition, among studies that have tested these effects, there has been a tendency to only examine the relationships between the appraisal constructs and maladaptive coping responses, not whether these maladaptive responses were negatively associated with protection motivation and subsequent behaviour (e.g., Ho, 2000; Pilch et al., 2021). However, the theory-implied associations between cognitive appraisals, maladaptive coping, protection motivation, and behaviour seem to be supported, although in relatively few studies (Norman et al., 2015).

In addition, very few studies have tested the mediating and moderating effect of maladaptive coping on relations between appraisals and protection motivation (e.g., Rippetoe & Rogers, 1987), and between appraisals and behaviour (e.g., Brown et al., 2005). The dearth of evidence for these effects means researchers and practitioners cannot corroborate these theory proposals relegating them to mere conceptual status. For example, a reason why appraisals may not be related to protective behaviours may be the adoption of maladaptive coping strategies. Take for instance individuals with low response efficacy, that is, individuals who appraise the target protective behaviour as

ineffective in resolving the perceived health threat. Such individuals may be more likely to adopt alternative coping strategies such as avoidance or venting emotions in order to manage the perceived threat and concomitant anxiety. This would be manifested in negative indirect or mediated effects of appraisals on protection motivation and behaviour through adoption of maladaptive coping strategies. Use of such maladaptive coping strategies may also moderate effects of appraisals in the theory downward. For example, individuals who endorse maladaptive coping strategies such as avoidance would be less likely to form intentions to perform protective behaviours based on their coping appraisals, that is, endorsement of such strategy use may reduce the relevance of these beliefs for the individual. Tests of the mediation of effects of threat and coping appraisals on protection motivation, and behaviour by maladaptive coping strategy use and the potential moderators involved, should be more widely considered. These effects could play a detrimental role in undermining protection motivation and performance of health protective behaviours.

A final limitation of current tests of the theory is the relative dearth of tests of the interaction of the threat and coping appraisal constructs on protection motivation as originally specified by Rogers (1975). For example, high levels of perceived vulnerability with respect to a health threat may relate to stronger protection motivation when self-efficacy is also high. Multiple studies have reported two – and three-way interactions between perceived vulnerability, perceived severity, response efficacy, response cost, and self-efficacy, including interactions between perceived vulnerability and self-efficacy as outlined above (see Cismaru & Lavack, 2007 for a review), while other studies have not found evidence of interaction effects (e.g., Ruiter et al., 2003), but these analyses do not feature in the majority of tests of the theory in health contexts. Much of the current literature tends to focus on direct effects predicting protection motivation or behaviour without performing tests of interaction effects (e.g., Babazadeh et al., 2017; Kowalski & Black, 2021; Helmes, 2002; Tulloch et al., 2009). Similarly, considering whether the relationships between the theory constructs are direct, or 'additive', or more interactive could influence how the theory constructs in an intervention or experiment are manipulated (Cismaru & Lavack, 2007).

The onus is, therefore, on researchers to resolve this dearth of findings by considering proposing and testing these effects as standard when testing the theory. Specifically, this would necessitate measuring the appropriate constructs in theory tests and, critically, proposing and testing maladaptive coping as both a mediator and moderator of the effects of appraisals (e.g., self-efficacy) on protection motivation, and analysing proposed interaction effects in the theory. Such investigations would afford opportunities to evaluate the full range of attenuation and mechanistic effects as outlined in the theory and provide a more robust confirmation of the hypothesised pattern of effects as an accurate representation of the key processes which underlie health behaviour performance.

Extending the theory

While comprehensive tests of protection motivation theory effects are necessary to evaluate its utility in predicting behaviour, researchers have proposed that the theory be extended to encompass additional constructs, relationships between constructs, and variables not originally specified in the theory but represent additional processes or model external influences that extend the scope of the theory (e.g., Nudelman, 2023). Notably, researchers have suggested inclusion of variables such as past behaviour as a means to model some types of non-conscious process (e.g., Hodgkins & Orbell, 1998), and socio-structural variables (e.g., neighbourhood features, ethnicity; Schüz, 2017) and individual difference constructs (e.g., Big Five traits; Pilch et al., 2021) that represent environmental and intrapersonal conditions that affect model processes. Importantly, the inclusion of these additional variables has been suggested because they are expected to meaningfully contribute to the prediction of protection motivation and behaviour alongside the inclusion of original protection motivation theory constructs – a key concern when integrating additional constructs in any social cognition theory (Ajzen, 1991). Whether these additional variables provide a meaningful contribution to the theory, and thus should be included as additional predictors in the theory, is based

on two criteria: a strong conceptual basis and a robust empirical basis. That is, the researcher should provide a rationale as to why additional variables might lead to a better description of the targeted behaviour, and also specify the criterion on what is 'meaningful' in terms of accounting for additional variance. The latter criterion remains an open empirical question, which highlights the importance of the use of effect sizes in addition to statistical significance alone. Next, we review the contribution of theory and research that has included additional variables in the theory.

Past behaviour

Inclusion of past behaviour in theory tests is somewhat controversial given that researchers have long recognised that past behaviour is not a psychological construct per se and merely represents the extent of behavioural consistency, often measured through frequency reports of prior behaviour (Ouellette & Wood, 1998). That said, researchers have acknowledged that effects of past behaviour in theory tests can be informative as a means to infer key processes relevant to behavioural prediction. First, inclusion of past behaviour provides a test of theory *sufficiency* (see Ajzen, 1991). That is, past behaviour effects can provide indication of whether the theory is adequate in accounting for unique variance in behaviour beyond prior engagement. Social cognition constructs, like the appraisal constructs in protection motivation theory, may be highly correlated with past behaviour because these beliefs may align well with prior decision making (for a detailed rationale see Wood, 2017; Wood & Rünger, 2016). To the extent that they are very strongly aligned, it is possible that inclusion of past behaviour as an independent predictor of protection motivation and behaviour in tests of the theory may substantively attenuate effects of these constructs such that past behaviour is the only remaining predictor. This effectively renders the theory redundant as an account of motivation or behaviour, that is, the theory is *insufficient* or not fit-for-purpose in providing a viable account of these outcomes, which may indicate the potential for other unmeasured constructs to account for this relationship. By contrast, in the event the belief-based constructs are demonstrated to be impactful predictors when past behaviour is included in theory tests or, critically, account for, or mediate, the effect of past behaviour on behaviour, researchers will have indication of the sufficiency of the theory in accounting for unique variance in behaviour beyond prior experience. This has been noted in tests of other social cognition theories (e.g., Hagger et al., 2018; McEachan et al., 2011). Any residual indirect effect of past behaviour on future behaviour in the presence of the belief-based constructs, even if they are not fully attenuated, may also reflect effects of unmeasured constructs not captured by the included measures, which may highlight avenues for future research.

Second, past behaviour effects may reflect effects of other unmeasured constructs and associated processes in the theory. In other words, while past behaviour is not a psychological construct per se, its effects on protection motivation and behaviour may provide indirect evidence of the effects of other constructs and the processes they represent. For example, there has been extensive research suggesting that past behaviour effects may represent habit effects in other social cognition theories similar to protection motivation theory (Ouellette & Wood, 1998). Assuming habit as a construct is developed through performing a behaviour regularly and in the presence of stable contexts or cues, it has been proposed that past behaviour effects may reflect habit effects given that behavioural frequency is a key component of habit, and that behaviours performed frequently in a stable context have greater opportunity to be formed as a habit (see Ouellette & Wood, 1998; Wood & Rünger, 2016). If past behaviour does, in fact, reflect effects of habit on future behaviour, an independent measure of habit that reflects the defining characteristics of the habit construct, such as perceived automaticity of the behaviour and context stability (e.g., Verplanken & Orbell, 2003), should be included to test this prediction. In this case, habit would be expected to mediate the relationship between past behaviour and future behaviour alongside the appraisal constructs if the model is sufficient at predicting future behaviour (see Hagger et al., 2023). In addition to identifying highly consistent independent effects of past behaviour in social cognition theory tests across multiple studies (e.g., Hagger et al., 2018), researchers have also demonstrated that past

behaviour effects on behaviour are larger for behaviours that are more likely to be formed as habits relative to intentions (Hagger et al., 2023; Ouellette & Wood, 1998; Webb & Sheeran, 2006).

Alongside this, effects of past behaviour in theory tests may also reflect effects of other unmeasured constructs implicated in decision making. For example, this may be the case for constructs that represent automatic processes that affect behaviour beyond the awareness of the individual, such as measures of implicit attitudes. This has been corroborated in previous research demonstrating that past behaviour effects on behaviour are mediated by measures of constructs representing these implicit processes (Phipps et al., 2020), indicating that past behaviour may reflect multiple types of non-conscious processes underlying behaviour, along with habit.

Although tests of protection motivation theory that include past behaviour and its potential mediators are relatively sparse, there is research that has done so providing a template for researchers to follow. For instance, Hodgkins and Orbell (1998) examined the role of past behaviour in a test of the theory in the context of breast self-examination to prevent breast cancer. Their results indicated that inclusion of past behaviour as a predictor attenuated effects of the appraisal construct effects on protection motivation so that they were not distinguishable from zero with past behaviour as the only remaining predictor. Similarly, a study by Milne and Orbell (2000) also observed similar attenuation effects in the context of breast self-examination, and this has also been the case in research on other social cognition theories such as the theory of planned behaviour applied to physical activity (e.g., Hagger et al., 2002). These findings suggest that, in the context of this particular behaviour and population, the theory did not offer a sufficient explanation of motivation, and that other variables outside of the theory may be mediating the relationship between past behaviour and protection motivation. This is a particularly important finding given that omission of past behaviour may have led the researchers to draw different conclusions. However, it should be noted that other studies have provided some indication of theory sufficiency for protection motivation theory (e.g., Preissner et al., 2023; Van der Velde & Van der Pligt, 1991) and other social cognition theories (e.g., McEachan et al., 2011). These studies indicated unique effects of theory constructs on protection motivation or intentions when past behaviour effects were included in the model. Therefore, it is important to note that although some of these theory tests did not support theory sufficiency, isolated studies testing theory effects, or even syntheses applying the theory in narrow behavioural contexts, should not lead researchers to conclude that the theory is overall not sufficient or redundant, or that the hypothesis of sufficiency for a particular theory should be rejected for the particular population or behaviour. Rather, it raises questions regarding the validity of the theory in particular population groups or behavioural contexts, and illustrates the need for tests that encompass past behaviour effects across multiple contexts, populations, and behaviours that provide converging evidence for this pattern. Researchers should therefore seek to include measures of past behaviour as standard in predictive studies testing protection motivation theory effects.

Additional constructs

Researchers have also advocated for the inclusion of constructs from other theories as additional predictors of protection motivation and behaviour within tests of the theory. This advocacy is in keeping with suggestions that social cognition theories should be open to the inclusion of additional constructs that represent important processes not encompassed by the theory and potentially account for unique variance in motivational and behavioural outcomes (Ajzen, 1991; Conner & Norman, 2015). For example, theorists have proposed inclusion of constructs such as positive and negative affect (Grindley et al., 2008), habit and implicit attitudes (Milne et al., 2002), and normative influences (Ajzen, 1991; Fishbein & Ajzen, 2011; see also Hagger, 2019), which are likely to serve as more proximal determinants of behaviour, as well as personality traits (Kaspar & Nordmeyer, 2022), which are expected to operate as distal determinants of behaviour mediated by the theory constructs (Norman et al., 2015), as additional predictors in tests of the theory.

Research augmenting the theory to include additional constructs has provided indication that such modifications aimed at accounting for non-conscious or impulsive processes may be conceptually informative. For example, affective attitude, which represents the extent to which performing the target protection behaviour evokes, or will evoke, positive or negative emotional responses, has been examined as an additional predictor of protection motivation and a mediator of the relationship between perceived susceptibility and protection motivation in the context of condom use (Bryan et al., 1997). Affective attitudes, along with perceived benefits, were found to partially mediate the effect of perceived susceptibility on protection motivation, suggesting that the association between individuals' appraisals of threat to health and protection motivation may be partly attributable to their emotional responses to performing the target behaviour. Similarly, implicit attitude, a construct which represents learned associations between a behaviour and positive or negative beliefs that are activated outside of conscious awareness in the presence of a corresponding cue, has been included as a predictor of health behaviour alongside conscious responses. For example, Millar (2011) examined implicit attitudes as a predictor of dental flossing behaviour alongside other social cognition theory constructs (e.g., intention), including those from protection motivation theory (e.g., self-efficacy). The addition of effects of implicit attitudes in the model alongside effects of self-reported intentions, explicit attitudes, self – and task-efficacy, and perceived behavioural control improved the variance accounted for in behaviour at multiple time points. These examples illustrate the potential for additional constructs to enhance the predictive validity of the theory in that they represent a broader portfolio of processes that could be implicated in the formation of protection motivation and the enactment of behaviour. However, such research is not the norm – researchers have tended to confine their tests of the theory to a narrow range of constructs from the original theory. This represents a clear avenue for future research that systematically examines effects of constructs like affective and implicit attitudes as additional, independent predictors of protection motivation and behaviour to evaluate the extent to which such constructs may add to the variance accounted for by the theory and, in doing so, increase its predictive validity.

Adopting alternative study designs to test theory inferences more effectively

Theorists and researchers have consistently identified the limitations of a heavy reliance on correlational designs to tests predictions of theories such as protection motivation theory, particularly the limits such designs place on capacity to infer directional and causal effects (e.g., Weinstein, 2007). In addition, correlational analyses do not account for key properties of the constructs involved such as stability and temporal change, which are important if the theory tests are to account for 'real-world' variability in these constructs and how they affect theory predictions. Given these limitations, researchers have advocated for the adoption of alternative study designs to improve the robustness and breadth of inferences that can be derived from theory tests, particularly causal and directional inferences. Specifically, researchers have advocated for the adoption of experimental, intervention, and forms of longitudinal panel designs, all of which permit enable better inference of causation and direction in tested effects (Hagger, 2025; Hagger et al., 2020b).

Experimental and intervention designs

The overall reliance on correlational designs to test protection motivation theory predictions notwithstanding (Milne et al., 2000), the number of studies adopting experimental or intervention designs is increasing. These studies typically involve exposure of participants from the population of interest to messages targeting theory predictors (e.g., threat and coping appraisals, self-efficacy, response efficacy) in the form of persuasive communications, for example, in the form of print or online media or verbal communication (Orbell et al., 2020). However, a limitation of many studies employing such designs is that the messages tend to target change in multiple constructs from the theory simultaneously (e.g., S.-C. S. Li et al., 2020; Rippetoe & Rogers, 1987), an approach that enables evaluation of the overall efficacy of the intervention but falls short as a means to

isolate the unique effects of each technique used. In addition, it precludes evaluation of the techniques that affect change in the behavioural outcome in accordance with the putative mediating mechanism specified by the theory, known as the *mechanism of action* (Hagger, 2025; Hagger et al., 2020; Michie et al., 2018; Rothman, Klein, et al., 2020). To do so, studies would need to adopt more complex *full factorial* designs in which each technique used is delivered separately and in conjunction with others.

An illustrative example of this approach in the context of protection motivation theory might entail a researcher developing separate messages targeting change in threat appraisals (e.g., a message highlighting the risks of not performing the protective behaviour) and self-efficacy (e.g., a prompt to individuals to successfully practice performing the behaviour), respectively, and their independent effects on protection motivation or behaviour tested in separate intervention conditions relatively to control conditions in which the other message was absent, or both were absent. This would enable observation of the extent to which each separate technique in the intervention is associated with change in both the behavioural outcome and measures of the targeted mediating construct. Confirmation of the mechanism is gained by assessing whether change in the construct measure as a result of the delivery of the technique mediates the concomitant change in the behavioural outcome. The specific constructs of interest for each study should have an adequate theoretical basis and be consistent with prior evidence from the literature. Researchers would, therefore, need to be selective in identifying conceptually important and practically significant two – or three-way interactive effects to test in factorial designs – testing a full six-way interaction between all main constructs in protection motivation theory would not likely be feasible given a very large sample size requirement and would not necessarily need to be implemented as standard. These guidelines would also apply if researchers proposed to test interactive effects of the threat or coping appraisals (e.g., interactions between vulnerability and severity) on protection motivation or health behaviour. However, threat and coping appraisals do not necessarily have to be segregated into their separate components, and this highlights the importance of formative research identifying whether it is vulnerability or severity which is most salient in driving the protection behaviour of interest.

There is precedent for the employment of these kinds of design to test these effects in protection motivation theory (Courneya & Hellsten, 2001; Dodge et al., 2023; Wurtele & Maddux, 1987). For example, Wurtele and Maddux (1987) employed a full factorial design to examine the isolated and interactive effects of manipulations targeting multiple components of protection motivation theory to promote physical activity intentions and behaviour. Their manipulations consisted of written communications targeting change in four key constructs from the theory: perceived severity, perceived vulnerability, response efficacy, and self-efficacy. The study conditions were characterised by the presence or absence of each message in a $2 \times 2 \times 2 \times 2$ factorial design. Results provided support for the main effects of each manipulation on its respective theory construct, multiple two – and three-way interactions between the construct manipulations on change in appraisals, main effects of the construct manipulations on exercise intentions and behaviour consistent with hypotheses, and some two – and three-way interaction effects of the construct manipulations on exercise intentions and behaviour, most notably interactions for vulnerability, self-efficacy and response efficacy, which is consistent with the notion that messages targeting threat and coping appraisals simultaneously are likely to have the greatest efficacy in changing intentions and behaviour relative to manipulations of each component in isolation.

In addition to affording tests of these isolated mechanisms of action, factorial designs also provide the opportunity to test whether separate isolated techniques work *interactively* to produce greater change in behaviour beyond the isolated effects of each of alone. Returning to the previous illustrative example involving adoption of techniques (e.g., presentation of persuasive messages) targeting change in threat appraisals and self-efficacy in isolation and synergistically implies a 2×2 factorial design with participants randomly assigned one of four groups: two would receive each technique in isolation, a further group would receive both techniques

simultaneously, and a control group would receive neither. This is a similar, but more simplified, example to the study conducted by Wurtele and Maddux (1987) employing the $2 \times 2 \times 2 \times 2$ factorial design, where groups of participants systematically received combinations of messages targeting change in four theory constructs. Alongside affording a test of the effect of each technique on the outcome of interest (e.g., protection motivation and health behaviour participation) and the theory-stipulated mechanisms of action through mediation as suggested earlier, such designs would test the extent to which parallel presentation of messages targeting two or more theory constructs led to greater change in the targeted outcomes beyond the effects of each alone.

To date the adoption of such designs to test main and interactive effects of protection motivation theory interventions on outcomes, with accompanying mechanism tests, are rare. Researchers should be encouraged to conduct such tests, using designs such as those specified above, to provide more robust evidence not only of causal effects in the theory, but also the mechanisms of action and interactive effects of isolated techniques that target theory constructs.

Stability, directionality, and reciprocity in theory effects

There is also a need for studies that examine effects of construct stability and directional patterns of prediction in protection motivation theory predictions over time. Studies that adopt longitudinal research designs that measure theory constructs and protection motivation and behavioural outcomes on multiple occasions may provide a potential solution. Pre-eminent among such designs are variants of cross-lagged panel designs, particularly those that have been recently advocated by research methodologists (e.g., Orth et al., 2021; Usami, 2021). Such designs have seldom been utilised in studies testing protection motivation theory predictions. These designs entail administering measures of theory constructs (e.g., threat and coping appraisals, self-efficacy), protection motivation, and behavioural outcomes on multiple occasions (e.g., Lindwall et al., 2011). Such designs would allow researchers to account for the extent of construct change over time attributable to their stability, that will likely affect associations between the constructs and the motivational and behavioural outcomes. In addition, these types of design allow for the better inference of the direction of the proposed effects through the estimation of cross-lagged effects among theory constructs and these outcomes. For example, collecting panel data on protection motivation theory would afford researchers with means to test whether protection motivation predicts subsequent behaviour as proposed, whether behaviour predicts protection motivation over time, or whether both effects are supported, that is, reciprocal effects.

Adopting longitudinal panel designs to test protection motivation theory hypotheses would also enable tests of the moderating effects of the stability in intention (or protection motivation) on the intention-behaviour relationship. Intention stability could be calculated using a number of indices, such as the sum of the absolute difference of intention measures at two time points (e.g., Sheeran & Abraham, 2003), and, as such, would not require the use of any additional construct measures. The moderating effects of intention stability is primarily derived from research on other social cognition theories, particularly the theory of planned behaviour. Relatively stable intentions have been found to consistently lead to an increased likelihood of intention translation into subsequent behaviour (Ajzen, 1991) as indicated by larger intention-behaviour effects when intentions are relatively stable (Conner & Godin, 2007; Sheeran & Abraham, 2003). By implication, this moderating effect would also be expected to in protection motivation theory and would indicate protection motivation stability as a key variable of interest for researchers testing theory effects and may provide an additional condition on which protection motivation-behaviour relations depend (Conner & Godin, 2007).

In addition, panel designs also provide the opportunity to establish whether the within-occasion effects among theory constructs are stable over time, known as *stationarity* (Gollob & Reichardt, 1987). For example, this would enable a test of whether the association between threat or coping appraisals and protection motivation remains relatively consistent, or is highly variable, over time. Where temporal variability in a relationship is high, it may be that the stability and cross-lagged

effects are insufficient in maintaining the relationship between key constructs over time and the effects may eventually reduce to the null, known as *entropy* (Hagger & Hamilton, 2023; Hertzog & Nesselroade, 1987). However, in the case of protection motivation theory, consistent with longitudinal tests of other social cognition theories for which there is a substantive evidence base comprising longitudinal designs, a truly entropic pattern of effects is unlikely. Maintenance of the within-occasion effects even when stability and cross-lagged effects are less than perfect is likely due to other extraneous unmeasured constructs that might promote stability. These may include factors in the environment that offer support, such as resource availability or social support, or intraindividual factors, such as individual difference traits like conscientiousness or self-control.

Some studies adopting longitudinal panel designs to test protection motivation theory effects have reported reciprocal effects among some of its constructs, while others have found null effects. For example, Dorsey et al. (1999) found reciprocal relations between self-efficacy and a health risk behaviour, drinking alcohol in excess. By contrast, Van der Velde and Van der Pligt (1991) found no evidence for reciprocal relationships among maladaptive coping and threat or coping appraisals for AIDS preventive behaviours. These inconsistencies indicate that further research is needed in order to draw definitive conclusions regarding stability, directionality, and reciprocity in effects across populations, contexts, and behaviours. A systematic review may not be indicated to draw this conclusion, given the relative dearth of studies adopting these types of design to test protection motivation theory predictions, as well as research on the predictions of other social cognition theories stressing this concern (see, for example, Hagger & Hamilton, 2023; Kothe et al., 2019). There is also need for research testing additional temporal processes such as stationarity and entropy. Finally, researchers need to consider the type of panel design that should be utilised to test these proposed effects, such as random-intercept cross-lagged panel designs which, to some extent, superseded standard panel designs by accounting for intraindividual stability in constructs (Usami, 2021). The utility of research adopting panel designs is that they may facilitate future research syntheses that enable tests of these effects across the current literature and their consistency as well as the extent to which they may vary according to key moderating conditions, as has been done recently for other social cognition theories (e.g., Hagger & Hamilton, 2023).

Effects of moderator variables

Theories such as protection motivation theory, in common with other social cognition theories, assume that their predictions represent generalisable effects that should hold across individuals, behaviours, and contexts. However, researchers have also acknowledged the theory-stipulated effects may vary due to key contextual, individual difference, and environmental factors (see Ajzen, 1991; Balla et al., 2024; Hagger, 2025; Hagger & Hamilton, 2023). This acknowledgement is based on the premise that individuals' processing of social information prior to making behavioural decisions is dependent on variables that likely determine the relative size or strength of the proposed predicted effects in the theory and reflect potential boundary conditions or auxiliary assumptions that determine when the theory predictions are likely to operate or hold. Moderators do not, therefore, necessarily invalidate theory predictions, but serve to qualify its predictions and the conditions likely to determine their operation, and could be considered 'auxiliary assumptions' (see Trafimow, 2012). Testing the effects of moderator variables in theories like protection motivation theory, therefore, is a crucial step to identifying the conditions in which the theory will be most efficacious in describing behaviour.

While there has been some attempts to test moderators of effects in applications of protection motivation theory in the health domain (e.g., Plotnikoff & Trinh, 2010; Zhang et al., 2019), these analyses have tended to focus on sample characteristics (e.g., age, gender; Guo et al., 2015; Luo & Mou, 2022; Plotnikoff et al., 2009) with relatively few studies systematically testing effects of other moderators such as individual differences (e.g., psychological traits such as need for cognition), and structural or environmental variables (e.g., access to health-related resources).

Research examining the moderating effects of these variables on theory effects afford researchers capacity to draw some key conclusions with respect to the generalizability of its effects or whether they are conditional on certain factors. For example, tests of moderators enable evaluation of whether or not the theory predictions hold *regardless* of the moderator. Such tests also enable identification of conditions that might affect the relative contribution of the different theory constructs to the prediction of protection motivation or behaviour. In addition, the tests may also assist in evaluation of whether intervention effects based on the theory vary across moderator levels, and the extent to which they operate through their nominated mediators, that is, whether the moderator affects the intervention mechanism of action (see also Rothman & Sheeran, 2021). Taken together, such moderator analyses may contribute evidence to support or disconfirm the generalizability of theory effects and identify potential conditions in which researchers may expect theory effects to vary or place bounds on its applicability.

To illustrate the importance of systematically examining the effects of moderators of protection motivation theory predictions, we outline two types of moderator variable that have not been widely examined in applications of the theory: socio-structural variables and personality. Researchers have only recently begun to examine how socio-structural variables (e.g., income, education) are implicated in the processes by which belief-based constructs from social cognition theories like protection motivation theory relate to motivational and behavioural outcomes. This represents an important shift away from treating such variables as mere covariates to be 'factored out' of analyses testing theory predictions toward examining them as key influences on the mechanisms represented by theory effects. For example, researchers have indicated that average personal or household income, a key indicator of socio-economic status within social structures, moderates relations between social cognition constructs (e.g., perceived behavioural control or self-efficacy, attitudes) and behaviour (e.g., physical activity participation) in tests of social cognition theories in health contexts (Schüz et al., 2020). In addition, socio-structural variables indicating socio-economic status (e.g., household income, employment status) have been identified as moderators of the intention-behaviour relationship in multiple behaviours (e.g., breastfeeding initiation, physical activity; Conner et al., 2013), such that smaller intention-behaviour effect sizes were observed in those with lower income or do not have regular employment. These effects indicate that individuals at the lower end of the socio-economic spectrum are less likely to follow through on their intentions. Low-income groups may have less access to resources (e.g., capacity to afford healthy food) or facilities (e.g., access to gym or sport facilities) that serve as barriers to action despite high motivation.

As an illustration of the potential moderating effects of socio-structural variables on the predicted effects between constructs in protection motivation theory, Amireault et al. (2008) found that individuals reporting higher income status exhibited larger positive effects of perceived behavioural control, a construct equivalent to the self-efficacy construct from protection motivation theory, on leisure-time physical activity behaviour. Similarly, Schüz et al. (2020) revealed a positive moderation effect of socio-economic status on the relationship between attitude, a construct parallel the response efficacy and response costs constructs from protection motivation theory as measured in this study, and participation in multiple health behaviours, such that those from high socio-economic status backgrounds more likely to act in accordance with their attitudes. This pattern of effects has been surmised to represent a key auxiliary prediction of the theory. For example, individuals from lower socio-economic backgrounds have limited access to resources or have intensive occupational commitments, which means they will have less access to facilities or may have to work long hours in their vocation, both of which are key barriers to physical activity. Thus, even if they believe in their capability of performing physical activity, or that physical activity will result in certain outcomes, such perceptions are less likely to lead them to perform the behaviour because of the constraints reflected in their social conditions. Findings from these studies suggest that such moderating effects may operate in protection motivation theory, but there is very little research explicitly testing them. There is, therefore, need for researchers to systematically examine the

potential for such socio-structural variables to moderate theory effects by including relevant measures of these variables alongside the theory constructs when testing the theory.

Similarly, personality constructs and other traits have been examined as candidate moderators of effects of protection motivation theory constructs on motivational and behavioural outcomes. Such moderators test a generalised premise that the extent to which individuals are motivated to act in accordance with their appraisals and beliefs is conditional on intrapersonal conditions that may affect their decision making (for similar examples see De Bruijn et al., 2009; Rhodes, Courneya, & Hayduk, 2002). As an example in the context of protection motivation theory, uncertainty orientation, a construct that reflects how individuals typically represent and respond to uncertainty in their environment, has been found to moderate the relationship between perceived threat and acceptance of disease screening and disease information seeking (Brouwers & Sorrentino, 1993). Uncertainty-oriented individuals, who tend to be motivated to resolve uncertainty, may be more likely to seek out information regarding diagnosis of a disease under conditions of both high appraisals of threat and high appraisals of ability to cope, in line with expectations outlined in protection motivation theory. Certainty-oriented individuals, who tend to be more likely to act in situations in which uncertainty is low, however, may be motivated to avoid information regarding their diagnosis of a disease under these same circumstances. Counter to theory hypotheses, even if such individuals believe they have high personal capacity to receive screening for a disease, and that a disease would be personally threatening to their well-being, these beliefs would be less likely to lead to higher intentions or likelihood of enacting the behaviour due to the inherent uncertainty of the diagnosis and the potential threat of this diagnosis to their health. These results are empirically demonstrated and discussed further in Brouwers and Sorrentino (1993).

A number of other personality traits also show promise as moderators in social cognition theories, such as conscientiousness or trait self-control, which may moderate the relationships between appraisals and health behaviour performance as well as the relationship between intention and behaviour (e.g., Conner & Abraham, 2001; Rhodes, Courneya, & Jones, 2002). However, findings of these effects are less equivocal for personality. For example, Rhodes et al.'s (2022) systematic review of moderators of the intention-physical activity behaviour relationship describe a consistent moderation effect for conscientiousness, but not for other traits such as agreeableness and openness to experience. It is clear that research examining effects of these moderators on protection motivation theory effects is in its infancy, and researchers are encouraged to consider testing such moderators to better capture the intrapersonal conditions on which theory predictions depend and provide a larger evidence base of these effects. Beyond providing important knowledge on the conditional basis of theory predictions, such evidence may also provide indication of which segments of the population that may be more responsive or receptive to certain communications and interventions aimed at changing behaviour by changing theory beliefs and where such interventions may be less efficacious without accounting for pervading intrapersonal conditions.

Measurement issues

A final concern in research testing protection motivation theory hypotheses is the lack of consistency in the measurement and operationalisation of theory constructs, an issue which has also been highlighted in tests of other social cognition theories (e.g., Hagger et al., 2020b). Specifically, the items selected to measure theory variables may impact observed effects in studies testing theory predictions. For example, effects of coping appraisals on protection motivation and behaviour in the theory may vary when the items used focus on outcomes that may not be salient to the individual. As an illustration, Wulfert and Wan (1993) observed larger effects of response efficacy on condom use when the items used to measure the construct focused on pregnancy prevention rather than disease prevention in a sample of undergraduate students. Similarly, measures that do not have appropriate correspondence with outcome measures such as protection motivation or behaviour may also influence theory effects (Ajzen, 1991). For example, Courneya (1994) found that the

effects of measures of intention, a construct synonymous with protection motivation, on physical activity behaviour were larger when the scale format (e.g., dichotomous or continuous response scales) of the intention and behaviour measures corresponded closely.

Alongside this, researchers may adopt measures that vary substantially in terms of item content but label those measures similarly as the same construct. For example, measures of maladaptive response rewards have referenced either intrinsic or extrinsic rewards, or both (e.g., MacDonell, 2013), or measures of financial and monetary benefits of not performing the target behaviour (e.g., Eberhardt & Ling, 2021). Such issues have potential to introduce method variance in studies testing theory effects and present problems to researchers when making comparisons across studies. This is also likely to introduce additional variability to the averaged sizes of theory effects in quantitative syntheses of research, such as meta-analyses.

It is therefore important that researchers seeking to compare theory effects take measurement issues into account when doing so and consider the consequences that such measurement variation could have when testing the theory and in drawing inferences. One means to allay the increased error variance would be to develop and apply a formal *classification* procedure that provides standardised definitions of theory constructs and prototype measures ensure measures use conform. An illustration is provided in guidelines provided for the development of measures of constructs of the theories of reasoned action and planned behaviour. Such guidelines provide standardised definitions and prototype measures of theory constructs to minimise variability measure content and operationalisation in research testing the theory (e.g., Ajzen, 1985, 2002; Ajzen & Fishbein, 1980). Others have adopted a 'meta-theoretical' approach by classifying constructs across theories into a sets of constructs with standardised labels that capture constructs typically included the theories (e.g., Cane et al., 2012; McMillan & Conner, 2007; Peters & Crutzen, 2022). The virtue of this approach has been summarised by researchers conducting meta-analyses of studies testing the effects of these theories in health contexts, observing that many studies have followed the stipulated guidelines thus minimising the observed variability in the measures used across studies (Hagger & Chatzisarantis, 2009; Starfelt Sutton & White, 2016).

It is also important that measures are appropriately tailored to make explicit reference to the specific risks or health threats and protection behaviours relevant to the target population, that is, there is appropriate *correspondence* between measures of theory constructs and outcomes. This has been a recognised feature of other social cognition theories and has been incorporated as a key measurement principle in guidelines for developing theory construct measures (e.g., Ajzen, 1991, 2002). This practice ensures appropriate specificity of the measures with respect to the target outcomes and ensures they are appropriate for the target population, which is expected to improve precision in predictive tests of theory hypotheses. It also informs intervention such that persuasive communications based on the theory target relevant outcomes of relevance to the target population.

One means to promote correspondence is to adopt open-ended formative research to elicit the salient outcomes and risks from groups of participants from the target population and use the outcomes and risk identified to develop construct measures (Ajzen, 1991; Francis et al., 2004; Hamilton & White, 2010). Such research typically involves using an open-ended survey or pilot interview research in which participants are prompted to list the relevant outcomes or risks with respect to the health threat or protective behaviour (e.g., Norman et al., 2015). These are then content analysed for the most frequently occurring outcomes and risks, and used in the development of measurement items (for further details of this approach see Ajzen, 2002). While this practice has been frequently, albeit not universally, used to develop corresponding measures for social cognition theories like the theory of planned behaviour, this has not been the norm for research on protection motivation theory. That said, there is research that has provided precedent for this practice to be modelled in future research applying the theory. For example, when evaluating their child's perceived vulnerability of worsening vision impairment over time with compliance with treatment for amblyopia, Searle et al. (2000) used a qualitative interview pilot study to elicit parents' reported beliefs with

respect to this condition. Content analysis of the interviews revealed specific beliefs with respect to the uncertainty surrounding the risks of the outcome (child's worsening vision) and the importance of focusing on adherence to treatment. However, such pilot work is not common practice in research on protection motivation theory and is strongly advocated in the early formation stages of study measures to promote less error variability and greater measurement precision in research testing the theory.

A related ongoing measurement issue is the need for conditional measures of threat appraisals when testing theory predictions. Conditional measures entail prompting members of the target population to evaluate the health risks of failing to perform the target protection behaviour, the consequences of performing the target behaviour, and the health threat of the illness or condition taking recent and current behaviour into account (e.g., 'Considering that you are fully vaccinated against COVID-19, how susceptible do you think you are to contracting COVID-19 in the future?'). This is an issue that has been recognised in previous research applying the theory, but studies have tended not to implement these types of measure when applying the theory (Norman et al., 2015). Instead, researchers have tended to adopt generic measures of constructs that do not make reference to salient health risk and consequences or account for current behaviour. Use of conditional measures of threat appraisals may be particularly useful in capturing perceived vulnerability, as opposed to measures that do not make reference to the relevant personal health threat and past performance of the protection behaviour (e.g., 'How susceptible do you think you are to contracting COVID-19 in the future?'), by minimising individuals' tendency to under – or over-estimate their risk (Garcia et al., 2018). Use of measures of this type may help explain some of the inconsistent findings observed in theory tests, such as why some studies have observed positive relationships between threat appraisals and protection motivation or behaviour, while others have observed negative relationships. Measures that specify the health threat against which participants judge their risk in the context of prior risk and behaviour may account for this variability in risk appraisal effects across participants.

Finally, an over-reliance on self-report behaviour measures has been a long-standing concern and acknowledged limitation of research testing the predictions of social cognition theories, including protection motivation theory (Hessing et al., 1988). Although self-reported behaviour measures have been shown to correlate with non-self-report measures lending some support for their concurrent validity, the correlations tend to be modest in size (Dang et al., 2020). Numerous limitations may be responsible including poor recall, acquiescence bias, demand characteristics, and low reliability (Norman et al., 2015; Sheeran et al., 2017). To illustrate, meta-analyses of the theory of planned behaviour have found larger effects of the theory constructs on behaviour in studies adopting self-reported behavioural measures when compared with those that employed non-self-report measures (e.g., observation devices such as accelerometers for physical activity or micro-electromechanical systems (MEMS) for medication adherence; Armitage & Conner, 2001; McEachan et al., 2011). This implies that the additional error variance introduced in effect size estimates in studies employing self-report behavioural measures may be inflating theory effects. Non-self report behaviour measures have been suggested to minimise these biases such as use of surveillance cameras or trained coders to observe behaviour (e.g., Lapinski et al., 2013), accelerometers and other wearable devices to measure physical activity (e.g., Gaston & Prapavessis, 2014; Wou et al., 2018) or sleep (e.g., Hall et al., 2018), and MEMS devices on pill bottles for measuring medication adherence (e.g., Wu et al., 2008). Of course, no behavioural measure can be truly considered as providing 'objective' or unbiased behavioural assessment, as all are associated with some degree of bias. For example, behavioural observation is limited by the attention and coding of the observer, and the use of wearable and MEMS devices have limitations that include data loss and potential to affect the behaviour of the participant in themselves (e.g., Finkelstein et al., 2016). A further downside is that such measures can be costly and thus impractical for use in some studies. That said, such measures are typically associated with fewer of the biases associated with self-report measures. As a consequence, adoption of non-self-report measures should be considered best practice in theory tests to provide

greater precision in measurement and minimise measurement error and, when this is not possible, concurrent validity data on the self-report measures adopted with non-self-report measures should ideally be reported.

Summary and conclusion

Promoting performance of health-enhancing behaviours and the reduction of health-risk behaviours through intervention is a recognised strategy for the prevention of chronic disease development and associated maladaptive health outcomes. Behavioural interventions should be informed by theories derived from the behavioural sciences, particularly psychology, to be optimally effective in changing health-enhancing behaviours. Protection motivation theory is a prominent theory that has been employed to identify the determinants of health and health risk behaviour that might be modified through intervention. While the theory predictions have been generally supported in predictive and experimental research there are outstanding issues that hinder its utility in identifying the determinants of behaviour and the mechanisms that underpin behaviour change. In this review we aimed to highlight these issues and outline potential solutions that serve as an agenda for future research on the theory. The key issues highlighted were: a lack of comprehensive tests of the theory and associations among its constructs; failure to routinely account for past behaviour and test theory sufficiency; a relative absence of wide-spread integration of additional constructs in theory tests; a lack of research adopting of study designs that test longitudinal effects, interactions, and mechanisms of action within the theory; a paucity of tests of moderators that may account for observed variation in theory effects across studies; and adoption of measurement practices that hinder precision of theory tests (e.g., low measurement correspondence, use of self-report behaviour measures).

To account for these evidence gaps, we propose that future research applying the theory in health behaviour contexts should attempt to conduct rigorous tests of the theory encompassing most or, preferably, all theory constructs with an appropriate conceptual rationale for the selection, testing their direct and interactive effects, and including past behaviour to test theory sufficiency and as a potential moderator of the appraisal-protection motivation relationship. Future studies should also consider including other constructs that represent associated processes that may extend the scope of theory predictions. In addition, there is a need for studies testing causal and longitudinal effects in the theory consistent with its predictions (e.g., the effects of appraisals on protection motivation and behaviour), and mechanisms of action of interventions based on the theory. For example, we recommend the use of factorial experimental designs in which multiple theory constructs such as appraisals are manipulated along and simultaneously to examine their direct and interactive effects on behaviour. Further, we advocate adoption of the rigorous, recently advocated forms of longitudinal panel design to account for stability and assess directional and cross-lagged theory effects. Researchers should also consider evaluating effects of moderators such as individual traits as well as socio-structural variables in theory tests. Finally, standards for the measurement of protection motivation theory variables should be implemented, such as advocating for the adoption of conditional and specific measures of appraisals, widespread use of standard classifications for the theory variables, and widespread adoption non-self-report measures of behaviour.

Note

1. Although this is a feature of studies applying protection motivation theory, the same is true for research testing social cognition theory predictions more broadly. For example, research examining the theory of planned behavior in health behavior contexts has largely neglected testing the proposed moderating effects of perceived behavioral control on the effects of attitudes and subjective norms on intentions, and the effect of intention on behavior (see Hagger et al., 2022; La Barbera & Ajzen, 2021).

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