UC Merced

UC Merced Electronic Theses and Dissertations

Title

Protection Motivation Theory and Health Behavior: A Meta-Analysis

Permalink

https://escholarship.org/uc/item/4d47w55x

Author

Balla, Jessica Elizabeth

Publication Date

2025

Supplemental Material

https://escholarship.org/uc/item/4d47w55x#supplemental

Copyright Information

This work is made available under the terms of a Creative Commons Attribution License, available at https://creativecommons.org/licenses/by/4.0/

Peer reviewed|Thesis/dissertation

eScholarship.org Powered by the California Digital Library
University of California

UNIVERSITY OF CALIFORNIA, MERCED

Protection Motivation Theory and Health Behavior: A Meta-Analysis

A dissertation submitted in partial satisfaction of the requirements
for the degree Doctor of Philosophy

in

Psychological Sciences

by

Jessica Elizabeth Balla

Committee in charge:

Professor Sarah Depaoli
Professor Deborah Wiebe
Professor Martin S. Hagger, Chair

© 2025

By Jessica Elizabeth Balla

All rights reserved

The Dissertation of Jessica Elizabeth Balla is approved, and it is acceptable in quality and form for publication on microfilm and electronically:

Sarah Depaoli

Deborah Wiebe

Martin S. Hagger, Chair

University of California, Merced
2025

Table of Contents

Acknowledgements ..... **v**
Curriculum Vitae ..... **vi**
Abstract ..... **xii**
Introduction **1**
Protection Motivation Theory: Overview and Key Hypotheses 1
Variability in Findings and Limitations of the Extant Research 2
The Present Study 3
Method **7**
Search Strategy 7
Inclusion and Exclusion Criteria and Study Selection 7
Construct and Behavior Classification 8
Effect Size Data Extraction 8
Moderator and Covariate Coding 9
Data Analysis 12
Results **13**
Multilevel Multivariate Meta-Analysis of Correlations 13
Multilevel Meta-Analytic Structural Equation Models 14
Discussion **18**
Implications of the Theory Test 19
Effects of Moderators 21
Contribution, Limitations and Avenues for Future Research 24
Conclusion 26
References **27**
Appendices **35**
Figure 1: Diagrams of Full and Truncated Models 35
Table 1: Standardized Parameter Estimates of Full Model 36
Table 2: Standardized Parameter Estimates of Truncated Model 39

Acknowledgements

This dissertation and completion of my Ph.D. would not have been possible without the support I received from countless others. First, I would like to thank my advisor, Dr. Martin Hagger, whose guidance has been indispensable throughout my doctoral training. Thank you for providing such comprehensive and valuable mentorship that has shaped my abilities as an independent researcher now and surely for the remainder of my career.

To my committee members, Dr. Sarah Depaoli and Dr. Deborah Wiebe, thank you for your helpful feedback and encouragement during my time here at UC Merced. My work as a researcher and teacher has been greatly improved by your supervision, and your knowledge of the health and quantitative psychology fields is truly inspiring.

To my fellow SHARPP Lab grad students, you are such amazing and intelligent people! The day-to-day of graduate school would have been much more dreary without you all. I feel very lucky to have experienced the highs and lows of the program (and of life) with you these last five years, and am grateful that we happened to cross paths in this big world. I hope to keep in touch for years to come and cannot wait to see the incredible things you do with your futures.

To all my friends and family, you have shown me the serendipitous connection between science and love. Thank you so much for your unwavering support, and for believing in me even in times when I didn't believe in myself. Having you cheering me on throughout my educational journey has meant more to me than you know!

To my long-time best friend, Lily, thank you for being my anchor and keeping me sane throughout graduate school (and basically for the past fifteen years). Our long texts and phone calls, game sessions, coffee trips, concert escapades, and simply our time together, no matter the setting, all make everything feel right with the world.

Last but not least, to my Dad, thank you for being the best parent I could have asked for. Thank you for inspiring me, like yourself, to be curious, kind, tenacious, and patient, and for providing the foundation and love for me to grow higher than I ever thought possible. Let's just say that all those nights you spent helping me with my homework at the dining table growing up have paid off!

Curriculum Vitae

Education

Ph.D., Psychological Sciences May 2025
Health Psychology Concentration (expected)
University of California, Merced
Advisor: Dr. Martin Hagger

M.A., Psychological Sciences May 2022
Health Psychology Concentration
University of California, Merced
Advisor: Dr. Martin Hagger

B.S., Psychology *(Honors Program Graduate)* Jan. 2020
Summa Cum Laude
University of La Verne

Publications, Peer-Reviewed

Balla, J., & Hagger, M. S. (2024). Protection motivation theory and health behaviour: Conceptual review, discussion of limitations, and recommendations for best practice and future research. *Health Psychology Review*, 1-27. https://doi.org/10.1080/17437199.2024.2413011

Balla, J., Polet, J., Kokko, S., Hirvensalo, M., Vasankari, T., Lintunen, T., & Hagger, M.S. (2023). Predicting adolescents' physical activity intentions: Testing an integrated social cognition model. *International Journal of Behavioral Medicine,* 1-14. https://doi.org/10.1007/s12529-023-10156-3

Gamst, G., Ma-Kellams, C., Arellano-Morales, L., Meyers, L. S., **Balla, J.**, McCafferty, K., Verbarendse, K., Serpas, D., Rojas, A., Huffman, N., & Menendez, C. (2021). Development and validation of the Asian American Women's Shifting Scale (AsAWSS). *Asian American Journal of Psychology, 12*(2), 122-137. https://doi.org/10.1037/aap0000220

Gamst, G., Arellano-Morales, L., Meyers, L.S., Serpas, D., **Balla, J.**, Diaz, A., Dobson, K., Feller, C., Rought, S., Salazar, S., Garcia, S., & Aldape, R. (2020). Shifting can be stressful for African American women: A structural mediational model. *Journal of Black Psychology, 46*(5), 364-387. https://doi.org/10.1177/0095798420939721

Works Under Review

Hagger, M.S., Sas, S.V., **Balla, J.**, Benoit, T.Z., Primoceri, P., Smith, S.R., & Hamilton, K. Trait self-control and health behavior: Meta-analysis and test of a mediational model [Revise and resubmit].

Conference Presentations, Peer-Reviewed

Hamilton, K., **Balla, J.**, & Hagger, M.S. (2025, March 26-29). *Development of contextually-tailored COVID-19 vaccine messages for Latinos in California's Central Valley: The 'C4' project* [Symposium presentation]. Society of Behavioral Medicine 2025 conference, San Francisco, CA, United States.

Balla, J. & Hagger, M.S. (2023, April 26-29). *Using an integrated social cognition model to predict adolescent physical activity intentions* [Poster presentation]. Society of Behavioral Medicine 2023 conference, Phoenix, AZ, United States.

Balla, J. & Hagger, M.S. (2022, April 28-May 1). *Predicting physical activity in adolescents: Test of an integrated model* [Poster presentation]. Western Psychological Association 2022 conference, Portland, OR, United States.

Balla, J., McCafferty, K., Verbarendse, K., Aldape, R., Awad, N., Bench, R., Vargas, V., Lawson, M., Hernandez, I., Aguilera, B., Olvera, V., Huffman, N., Arellano-Morales, L., Meyers, L. S., & Gamst, G. (2020, October 28-31). *Shifting mediates racism-related stress of Asian American women* [Poster presentation]. Western Psychological Association 2020 virtual conference.

Balla, J., McCafferty, K., Verbarendse, K., Huffman, N., Menendez, C., Chao, T., Serpas, D., Rojas, A., Ma-Kellams, C., Arellano-Morales, L., Meyers, L. S., & Gamst, G. (2020, October 28-31). *A confirmatory factor analysis of the Asian American Women's Shifting Scale (AsAWSS)* [Poster presentation]. Western Psychological Association 2020 virtual conference.

Balla, J., Vargas, V., Huffman, N., Hernandez, I., Lawson, M., Aguilera, B., Serpas, D., Rojas, A., Gordon, C., Kwon, R., Meyers, L.S., & Gamst, G. (2020, October 28-31). *Effects of type of Latinx American landscaper on assessment of petty bourgeois mentality: A field experiment* [Poster presentation]. Western Psychological Association 2020 virtual conference.

Balla, J., Blankenship, H., Calzada, C., Huffman, N., Camacho, J., Price, J., Lukacs, A., & Bui, N. (2019, April 25-28). *The effects of social media influencers on self-esteem among college students* [Poster presentation]. Western Psychological Association 2019 conference, Pasadena, CA, United States.

Balla, J., Blankenship, H., Calzada, C., Smisek, W., Zhu, X., Dalton, J., Ontiveros, A., Gutierrez, A., & Bui, N. (2019, April 25-28). *The effects of social media influencers on life aspirations among college students* [Poster presentation]. Western Psychological Association 2019 conference, Pasadena, CA, United States.

Escobar, R., **Balla, J.**, Serpas, D., Rojas, A., Huffman, N., McCafferty, K., Verbarendse, K., Wang, V., Menendez, C., Ma-Kellams, C., Arellano-Morales, L., & Gamst, G. (2019, April 25-28). *A qualitative analysis of Asian American women's shifting attitudes in a community sample* [Poster presentation]. Western Psychological Association 2019 conference, Pasadena, CA, United States.

Aldape, R., **Balla, J.**, Diaz, A., Dobson, K., Feller, C., Garcia, S., Rought, S., Salazar, B., Serpas, D., Arellano-Morales, L., Meyers, L.S., & Gamst, G. (2018, April 26-29). *A structural mediation model predicting race-related stress of African American*

women [Poster presentation]. Western Psychological Association 2018 conference, Portland, OR, United States.

Research Experience

Doctoral Researcher Aug. 2020-
SHARPP Lab, Psychological Sciences Department; present
University of California, Merced
Advisor: Dr. Martin Hagger

Graduate Student Researcher Aug. 2023-
Psychological Sciences Department; University of California, Merced Aug. 2024
Supervisor: Dr. Martin Hagger
Project: 'Developing Community-Engaged and Contextually Tailored COVID-19 Vaccine Messages for Latinos in the Central Valley: The C4 Project'

Graduate Student Researcher Jun. 2022-
Psychological Sciences Department; University of California, Merced Aug. 2022
Supervisors: Drs. Martin Hagger and Anna Song
Project: 'A Scoping Review of Tobacco Flavor Bans and Their Effects on Smoking Cessation'

Undergraduate Research Assistant Apr. 2019-
Psychology Department; University of La Verne Dec. 2019
Advisors: Drs. Glenn Gamst and Roy Kwon

Undergraduate Research Chair Aug. 2018-
Psi Chi Honor Society; University of La Verne May 2019
Advisor: Dr. Ngoc Bui

Undergraduate Research Assistant Jan. 2017-
Multicultural Lab, Psychology Department; Dec. 2019
University of La Verne
Advisors: Drs. Glenn Gamst and Leticia Arellano-Morales

Professional Experience

Laboratory Manager Aug. 2023-
SHARPP Lab, Psychological Sciences Department; Aug. 2024
University of California, Merced

Journal Editorial Associate Mar. 2023-
Social Science and Medicine - Health Psychology Dec. 2023
Supervisor: Dr. Martin Hagger

Community Partners Webinar Breakout Session Facilitator Jan. 2022
Nicotine and Cannabis Policy Center; University of California, Merced

Psychology Research Conference Coordinator May 2019
9th Annual Psi Chi Student Research Conference; University of La Verne

Assistant Teacher Feb. 2019-

Fairplex Child Development Center (Pomona, CA) May 2019

Teaching Experience

Teaching Assistant, PSY120 – Health Psychology Jan. 2025-
Psychological Sciences Department; University of California, Merced present
Supervisor: Dr. Deborah Wiebe
Lectures presented: 'Physical Activity and Health'

Teaching Assistant, PSY126 – Science of Behavior Change Aug. 2024-
Psychological Sciences Department; University of California, Merced Dec. 2024
Supervisor: Dr. Martin Hagger
Lectures presented: 'Changing Behavior Using the Health Belief Model and Protection Motivation Theory'

Teaching Assistant, PSY010 – Analysis of Psychological Data Jan. 2023-
Psychological Sciences Department; University of California, Merced May 2023
Supervisor: Dr. Sarah Depaoli
Lectures written and presented: 20+ discussion sections led weekly with 60+ students total; 'Exam 2 Review'

Teaching Assistant, PSY125 – Cognition, Affect, and Health Aug. 2022-
Psychological Sciences Department; University of California, Merced Dec. 2022
Supervisor: Dr. Linda Cameron

Teaching Assistant, PSY183 – Human Behavioral Genetics Jan. 2022-
Psychological Sciences Department; University of California, Merced May 2022
Supervisor: Dr. Jennifer Hahn-Holbrook
Lectures written and presented: 'Research Methods in Behavioral Genetics'

Teaching Assistant, PSY120 – Health Psychology Aug. 2021-
Psychological Sciences Department; University of California, Merced Dec. 2021
Supervisor: Dr. Deborah Wiebe
Lectures presented: 'Health Behavior Theory'

Teaching Assistant, PSY010 - Analysis of Psychological Data Jan. 2021-
Psychological Sciences Department; University of California, Merced May 2021
Supervisor: Dr. Ren Liu
Lectures written and presented: 'Lab 3: Measures of Central Tendency and Variability'; 'Lab 6: Hypothesis Testing'; 'Lab 9: Related-Sample T-Test and One-Way ANOVA'; 'Lab 13: Repeated Measures ANOVA'

Teaching Assistant, PSY180 - Physiological Psychology Aug. 2020-
Psychological Sciences Department; University of California, Merced Dec. 2020
Supervisor: Dr. Darrin Tracy
Lectures written and presented: 'Exam 1 Review'; 'Exam 2 Review'; 'Exam 3 Review'

Invited Talks

Inclusive research methodologies: The 'C4' project. Mar. 2025

Interview conducted for the Sage Research Methods: Inclusive Research Methodologies multimedia collection (video publication expected in 2026).

Developing community-engaged and contextually tailored COVID-19 vaccine messages for Latinos in the Central Valley: The C4 project. Oct. 2023, Jun. 2024

Presentations given at Griffith University (Brisbane, Australia) HaPI Lab virtual meeting (Oct. 2023), and the California Collaborative for Public Health Research (CPR3) virtual works-in-progress session (June 2024).

Graduate school applications and experience. Mar. 2022

Presentation given at the University of La Verne Psi Chi Honor Society club virtual meeting.

Training/Certifications

Certificate in Quantitative Methods Jan. 2023

Psychological Sciences Department; University of California, Merced

Additional courses passed: PSY202C - Multivariate Analysis; PSY207 - Structural Equation Modeling; PSY210 - Item Response Theory

Publishing Your Work: Workshop Mar. 2022

Psychological Sciences Department; University of California, Merced

Missing Data Analysis: Workshop Jan. 2022

Quantitative Methods, Measurement, and Statistics Group; University of California, Merced

Open Science: Workshop Oct. 2021

Psychological Sciences Department; University of California, Merced

Structural Equation Modeling: Webinar July 2021

Quantitative Methods, Measurement, and Statistics Group; University of California, Merced

Methods for Meta-Analysis: Webinar Nov. 2020

Center for International Business Education & Research; Georgia State University

Preparing to Teach in the Online Environment: Three-Part Workshop Aug. 2020

Center for Engaged Teaching and Learning; University of California, Merced

Service

Academic Journal Peer Reviewer Nov. 2020-present

Applied Psychology: Health and Well-Being, Behavioral Sciences, International Journal of Environmental Research and Public Health, Psychology & Health, SAGE Open, Social Science and Medicine

Student Representative and Social Media Manager May 2023-Apr. 2025

Theories and Techniques of Behavior Change Interventions (TTBCI) Special Interest Group; Society of Behavioral Medicine

Honors and Awards

Distinguished Graduate Speaker in Psychological Sciences Award; University of California, Merced	2024
Health Psychology Research Dissemination Award; University of California, Merced	2023
2nd Place Poster Award, Division 52: International Psychology; Western Psychological Association	2019
Psychology Departmental Award in Academic Recognition; University of La Verne	2019
Dean's List (Fall 2016, Spring 2017, Fall 2017, Spring 2018, Fall 2018, Spring 2019); University of La Verne	2016-2019
Presidential Scholarship; University of La Verne	2016-2019

Professional Memberships

Society of Behavioral Medicine	2021-present
Psi Chi, International Honor Society in Psychology	2018-present

Abstract

Objective: Protection motivation theory is a prominent social cognition theory used to predict health-promoting and risk behaviors. The unique theory-implied effects on health behavior and candidate moderators of these effects across the literature remain unclear. We conducted a large-sample meta-analysis to examine the proposed direct and indirect effects of protection motivation theory constructs on health behavior and tested relevant measurement, contextual, and methodological moderators. **Method:** We identified studies reporting effect sizes among protection motivation theory constructs, protection motivation, and behavior in a systematic literature search. The proposed model was fit to the pooled correlation matrix among the theory constructs using multilevel multivariate meta-analytic structural equation modelling. **Results:** Results provided generalized support for key predictions of protection motivation theory, such as the direct effects of constructs included in threat and coping appraisals on protection motivation, protection motivation on behavior, and indirect effects of appraisals on behavior mediated by protection motivation. We also observed non-zero direct effects of self-efficacy and coping appraisals on behavior. Moderator and sensitivity analyses uncovered non-zero differences in model effects across moderator groups, with the exception of measurement validity, which did not lead to notable differences in patterns of effects. **Conclusion:** Findings support protection motivation theory constructs as unique and consistent correlates of health and risk behavior adoption, and corroborate the proposed processes involved. Our results highlight important moderating conditions, such as measure correspondence and conditional perceived susceptibility measures, that may amplify the size of theory effects. Further research is necessary to provide viable meta-analytic tests of the effects of maladaptive coping strategies – maladaptive response rewards was used as a proxy for this construct in the current study – on outcomes as proposed in the theory and effects of additional moderators on theory effects.

Introduction

Regular participation in health-promoting behaviors (e.g., physical activity, medication adherence) and cessation of health risk behaviors (e.g., smoking tobacco, drinking alcohol in excess) is associated with multiple adaptive health outcomes, including reduced non-communicable disease risk (Budreviciute et al., 2020), and a lower risk of premature mortality (Loef & Walach, 2012). However, population-level participation rates in health-promoting behaviors remain low (Centers for Disease Control and Prevention [CDC], 2021a) while rates for health risk behaviors remain high and continue to contribute substantively to chronic illness incidence and mortality (CDC, 2021b, 2023). Public health organizations and advocacy groups have, therefore, stressed the need for development and implementation of behavioral interventions targeting increased participation in health-promoting behaviors and reduction in participation rates of risk behaviors. To develop behavioral interventions that are optimally efficacious and efficient in promoting change in these behaviors necessitates identification of potentially modifiable determinants reliably related to participation in health-promoting and risk-related behaviors and the implicated processes. Evidence of determinants may assist in signaling candidate constructs that could be targeted for change by the content of behavior change interventions.

Theories of social cognition have been at the forefront of guiding research purposed to identify these determinants (Conner & Norman, 2025). Such theories assume that individuals' decisions to act are a function of their beliefs regarding their future performance of a given target health behavior (Hagger, 2025). Theories in this category typically encompass beliefs such as those relating to perceived risk and utility, personal capacity, and social influence with respect to performing the target behavior (e.g., Fishbein et al., 2001). These beliefs have an informational function in the theories in that they provide a basis for individuals to form intentions or motives to perform the behavior in future. A prominent example is protection motivation theory (Rogers, 1975), which has been applied extensively in research aimed at identifying belief-based health behavior determinants and specifying the processes involved.

Protection Motivation Theory: Overview and Key Hypotheses

A central hypothesis of protection motivation theory is that protection motivation, a construct synonymous with intention, is the most proximal health behavior determinant. Protection motivation is a motivational construct indicating an individual's preparedness or willingness to engage in a behavioral response to mitigate a health threat or enhance health in future. The theory predicts that protection motivation is a function of two sets of beliefs or appraisals with respect to health threats and their management: threat appraisals and coping appraisals. Threat appraisals represent beliefs about the risk of a given illness or condition to health, and typically encompasses the perceived severity of the health threat, perceived susceptibility to experiencing it, and fear of its consequences. Coping appraisals represent beliefs about the efficacy of a given behavior in promoting desirable health outcomes, known as response efficacy, the perceived benefits and costs of performing the behavior, and perceived personal capacity to perform the behavior, known as self-efficacy. These appraisals are expected to be informed by multiple sources of information, such as external (e.g., environment, observation) and internal (e.g., personality, prior experience) sources. The appraisals are also proposed to be related to maladaptive coping responses, such as avoidance or denial, that may be adopted to manage emotions but are not effective in managing the threat or expected to lead to

adaptive outcomes. Maladaptive coping responses and the perceived rewards of performing a maladaptive response are, therefore, expected to be negatively associated with protection motivation. Importantly, protection motivation is predicted to mediate the relationships between the social cognition constructs, threat appraisals and coping appraisals, as well as maladaptive coping strategies, and behavior.

Protection motivation theory has been applied extensively to predict health behaviors across multiple contexts, populations, and behaviors (Norman et al., 2015; Orbell et al., 2020). For example, meta-analytic syntheses of studies applying the theory in health contexts have provided generalized support for associations between the theory constructs across studies consistent with predictions, and demonstrated that the theory accounts for substantive variance in protection motivation and health behavior (Floyd et al., 2000; Milne et al., 2000).

Variability in Findings and Limitations of the Extant Research

The generalized support for theory predictions across the extant research notwithstanding, variability in the effects of theory constructs on protection motivation and health behavior has been observed across behaviors and population groups. For example, research reviews of the theory applied in physical activity contexts indicated that self-efficacy had larger effects on behavior in studies on nonclinical populations (Bui et al., 2013), while effects of threat appraisals were more salient than coping appraisals in studies on chronic illness populations (Plotnikoff & Trinh, 2010). However, while these reviews report the generalized 'weight of evidence' for the proposed theory effects based on study conclusions, they rely exclusively on the reported statistical significance of effects in the included studies and do not account for measurement artifacts such as sampling error that may bias conclusions regarding the effects.

Meta-analyses of applications of the theory in health behavior contexts provide some resolution by accounting for such artifacts, and indicate the averaged effect sizes among theory constructs corrected for some bias artifacts (Floyd et al., 2000; Milne et al., 2000). Prior meta-analyses of research testing theory predictions have reported considerable variability in effect sizes across studies for some effects after artifactual correction and revealed important differences in the pattern of key effects. For example, averaged effects of response costs on protection motivation and behavior vary in size and in sign across studies. Such inconsistencies imply the presence of moderators of theory effect sizes within and across studies. Consistent with prior meta-analyses of comparable social cognition theories, and with primary research applying the theory in health behavior contexts, candidate moderators of theory effects include conceptual (e.g., behavior type), methodological (e.g., time lag between theory and behavioral measures, study design), sample (e.g., age, gender, student status), and contextual (e.g., country-of-origin characteristics) variables. Examining the extent to which these moderators alter effect sizes among the theory constructs in a meta-analysis of the extant research applying the theory in health contexts may assist in resolving the observed heterogeneity. For example, such an analysis would permit estimation of the extent to which the average size and variability of theory effects in health contexts varied across studies according to levels of the moderator variables.

A further limitation of prior meta-analyses of research applying the theory in health contexts is the sole focus on bivariate correlations among theory constructs and behavior. Such analyses provide information on the average size and variability of effects among individual constructs, and between the constructs and protection motivation and

behavior. However, such an approach is silent on the unique contribution of each construct while simultaneously accounting for the effects of the others. This is pertinent given that the theory constructs overlap conceptually and empirically, and may, therefore, share variance with outcomes such as protection motivation and behavior. In addition, the theory also outlines the mechanisms by which its constructs relate to health behavior. For example, the effects of threat and coping appraisals on health behavior are predicted to be mediated by protection motivation.

For this reason, adoption of multivariate analytic techniques (e.g., path analysis, structural equation modeling) is considered de rigueur as means test theory predictions in primary research studies. However, prior syntheses of protection motivation theory research have not adopted the equivalent analytic approaches necessary to make such inferences (Balla & Hagger, 2025; Hagger & Hamilton, 2025). Doing so necessitates producing a matrix of averaged corrected bivariate correlations among theory constructs from a meta-analysis and using them as input for a model specifying the theory-based relations among them implemented using meta-analytic structural equation modeling. Such an analysis would also permit testing effects of candidate moderator variables on theory-implied associations among its constructs by estimating the model in groups of studies at different levels of the moderator and comparing its effects.

The Present Study

Accordingly, the current meta-analysis was purposed to provide a meta-analytic test of protection motivation theory hypotheses using synthesized data from studies applying protection motivation theory to predict health-related behaviors. Specifically, we aimed to test the unique theory-implied pattern of effects among the theory constructs, protection motivation, and behavior by estimating a meta-analytic structural equation model using the pooled correlation matrix among theory constructs from the included studies. We aimed to utilize multivariate analytic techniques to provide robust point and variability estimates of the unique effects of theory constructs on protection motivation and health behavior, which will serve to guide expected size and variability in theory effects for future theory applications in health contexts. The innovation of our analysis is that it moves beyond the strictly univariate analytic approaches adopted in prior meta-analyses of the theory, such that our estimates mirror those derived from primary research employing comparable multivariate techniques to test theory hypotheses. Further, we assume we will observe non-trivial heterogeneity in our estimates of theory effects derived from our meta-analysis, consistent with similar observations in prior meta-analysis of the theory and of social cognition theories, which would signal the likely presence of moderating variables. We therefore aimed to examine effects of candidate conceptual, methodological, and context-related moderators on the unique model effects. Our moderators were identified through a conceptual analysis of theory effects and prior meta-analyses of social cognition theories in health behavior contexts. We aim to test moderating effects by estimating our meta-analytic structural equation model of the theory in data from groups of studies defined by different levels of the moderator.

Full-Sample Tests of Theory Hypotheses

Our approach involved identifying relevant studies in a systematic search of published and unpublished research applying the theory in health behavior contexts, extracting relevant effect size data, and applying the multivariate analytic techniques to test theory effects consistent with the method adopted in previous meta-analyses of social cognition theories. Importantly, our analytic approach enabled us to test key theory

hypotheses using the meta-analytic synthesized data. The proposed model tested is illustrated in Figure 1a and the accompanying key theory-based hypotheses are summarized in Table S1.1 (supplemental materials)[1]. In the first instance, we expected to observe theory-consistent patterns of zero-order averaged correlations among the threat appraisal (perceived vulnerability, perceived severity, fear), coping appraisal (perceived self-efficacy, perceived response efficacy, perceived response costs), protection motivation, and maladaptive coping constructs, and health behavior (HC1-HC2). With respect to our hypotheses tested in our multivariate structural equation model of the theory (HF), we predicted non-zero positive effects of perceived susceptibility (HF1), perceived severity (HF2), fear (HF3), self-efficacy (HF4), response efficacy (HF5), response costs (HF6), and maladaptive coping (HF7) on protection motivation, and non-zero positive effects of protection motivation (HF8) and self-efficacy (HF9) on health behavior. We also predicted non-zero positive effects of perceived susceptibility (HF10), perceived severity (HF11), fear (HF12), response costs (HF13), self-efficacy (HF14), and response efficacy (HF15) on maladaptive coping. In addition, we predicted non-zero averaged indirect effects of threat (HF16, HF18) and coping (HF17, HF19) appraisals on health behavior mediated by protection motivation and maladaptive coping, respectively, and a non-zero averaged total effect of the appraisal constructs on behavior (HF20)[2,3].

Tests of Moderators

We tested hypothesized effects of our moderator variables on hypothesized effects of protection motivation theory in a truncated version of the model that aggregated distinct threat and coping appraisal constructs into theory higher order categories, which was necessary to ensure a sufficient number of studies available in each cell of the input correlation matrix for analysis[4]. The truncated model is illustrated in Figure 1b. Prior to moderator testing, we conducted analogous tests of model effects in our truncated version of the model in the full sample of studies. We expected to observe an identical pattern of effects consistent with theory hypotheses (HT). Specifically, we predicted non-zero positive direct effects of threat (HT1) and coping (HT2) appraisals and maladaptive coping (HT3) on protection motivation, of threat (HT4) and coping (HT5) appraisals on maladaptive coping, and of protection motivation (HT6) and coping appraisals (HT6.1) on health behavior. Finally, we expected non-zero indirect effects of threat (HT7) and coping (HT8) appraisals on health behavior mediated by protection motivation and maladaptive coping[5]. We subsequently compared theory-implied effects in our truncated model by estimating it separately in groups of studies at each level of our proposed categorical moderator variables. Our moderator hypotheses (HM) are summarized in Table S1 (supplemental materials).

---

[1]Our hypotheses, design, and analysis plans were pre-registered in advance at the Open Science Framework (OSF): https://osf.io/ayfb2.

[2]Hypotheses for the direct effect of self-efficacy on health behavior (HF9), and the indirect effects of threat (HF16) and coping (HF17) appraisals on health behavior, were not preregistered.

[3]Strictly speaking, the hypothesized indirect effects are effectively sums of indirect effects comprising the specific indirect effects of each threat (perceived susceptibility, perceived severity, fear) and coping (response costs, response efficacy, self-efficacy) appraisal construct on health behavior mediated by protection motivation alone and both protection motivation and maladaptive coping.

[4]A detailed rationale for, and description of, the truncated model used in the moderator analyses is provided in supplemental materials S2.

[5]Hypotheses for the direct effect of coping appraisals on health behavior (HT6.1), and the indirect effects of threat (HT7) and coping (HT8) appraisals on health behavior, were not preregistered.

Our first set of moderators focused on the characteristics and properties of measures used in studies to tap protection motivation theory constructs. First, we expected that theory effects would be larger in studies reporting evidence of the validity or reliability of measures used (referred to hereafter as 'measurement validity') relative to those that did not report measurement validity evidence (HM1). Our hypothesis was based on the assumption that validity or reliability evidence was indicative of the precision of the measures used in capturing the underlying construct of interest, which reduces potential for error variance in effect size estimates (Dixon & Johnston, 2019). Similarly, we also expected larger model effects in studies which adopted measures of the perceived susceptibility construct conditional on a specific behavioral response relative to studies adopting non-conditional perceived susceptibility measures (HM2), and in studies adopting measures with high correspondence between their construct and target outcome measures relative to those with low or nil measurement correspondence (HM3). These hypotheses are predicated on proposed conceptual arguments that researchers applying protection motivation theory, and other social cognition theories, in health contexts do not consistently adopt measures that make explicit reference to the outcome of interest. These concerns extend to the conditionality of the perceived susceptibility measures as well as construct measures more broadly – better correspondence assumed to improve predictive validity (Ajzen, 1991; Balla & Hagger, 2025).

Our second set of moderators focused on the characteristics of the health behavior and context targeted in studies testing theory constructs: behavior type and sample country-of-origin. First, we expected larger effects of coping appraisal constructs in studies targeting behaviors offering protection from illnesses or health conditions (e.g., healthy eating, physical activity) relative to studies targeting studies that present a risk to health (e.g., unhealthy snacking, alcohol consumption), while an inverse pattern of effects was expected for threat perceptions (HM4). This is based on prior studies examining effects of social cognition theory constructs in behaviors in these categories (e.g., Hagger & Hamilton, 2024; McEachan et al., 2011).

Second, we tested for differences in theory effects according to a panel of economic, ecological, and cultural dimensions based on the country of origin of the samples of the included studies. Specifically, we tested effects of cultural orientation (individualism-collectivism; HM5), Human Development Index score (HDI; HM6), parasite stress (HM7), power distance (HM8), tightness-looseness (HM9), and flexibility-monumentalism (HM10)[6]. These dimensions represent societal-level factors that may determine the extent to which constructs from social cognition theories account for variance in health behavior outcomes and, hence, their efficacy in guiding health behavior interventions (Fischer et al., 2024). Further, given most psychological theories, including social cognition theories, tend to be developed and validated in a narrow set of countries (Henrich et al., 2010; Rad et al., 2018), these characteristics may have implications with respect to the generalizability of protection motivation theory effects. Primary studies and meta-analyses of social cognition theories have reported variability

[6] We also considered testing effects of study country-of-origin national wealth on model effects based on gross domestic product (GDP) rankings held by the Central Intelligence Agency (CIA) World Factbook (CIA, 2024) as advocated by Fischer et al. (2024). However, a lack of available national wealth data for many of included sample countries precluded a moderator or sensitivity analysis for this index.

in theory effects attributable to cultural orientation (e.g., Bagozzi et al., 2001; Blanchard et al., 2008; Fischer et al., 2024; Fischer & Karl, 2022; Hagger et al., 2007), and there is preliminary evidence for the moderating effects of the other dimensions on theory effects (e.g., Cheng et al., 2016; Fischer & Karl, 2022; Li et al., 2022; Petrova et al., 2020). While there are studies testing predictions of social cognition theories in health contexts that have nominated specific directional effects for these moderators on theory effects (e.g., larger effects of constructs representing perceived social norms in studies on samples from countries considered collectivist or high in social tightness), we did not propose preregistered predictions for differences in effect size and direction of the effects across levels of each moderator on specific theory effects, given the relative dearth of prior data examining effects of these characteristics in protection motivation theory. Effects of these moderators on the estimated effects in the current study should, therefore, be considered exploratory. However, we note conceptual and empirical precedent derived from prior primary research and research syntheses testing the effects of moderators on effects of constructs with close conceptual similarity to those of protection motivation theory on salient health-related outcomes, such as intentions to perform, and actual participation in, health behavior that gave us cause to state some general expectations with respect to effects of the moderators in the current study. Specifically, we expected larger theory effects in samples that tend to endorse individualist cultural norms, experience lower levels of parasite stress, and that are more "loose" and "flexible" on indices of tightness-looseness and flexibility-monumentalism, respectively (see Fischer & Karl, 2022; Fincher & Thornhill, 2012). The prior research on which these predictions are based emphasized that a majority of social cognition theory constructs tend to focus on an individual's personal considerations with respect to future behavior performance (e.g., concerns about outcomes, appraisals of personal capacity to perform behaviors). The slant toward individual beliefs and perceptions are likely to have greater salience for intentions and behavior in samples recruited from countries that tend to foster and endorse individualist norms that place more emphasis on personal independence and individual choice, are less controlled by cultural norms and more tolerant of normative deviations ("loose" societies), and permit greater flexibility and adaptability. Such beliefs, by contrast, are likely to be less relevant to intentions and behavior in samples recruited from countries that tend to endorse collectivist norms that place emphasis on social roles and contribution to society, tend to be guided and constrained by normative influences ("tight" societies), and tend to favor stability and consistency, and these individual constructs would be expected to show smaller effects on these outcomes. In such societies, normative beliefs would be expected take precedence in decision-making and be more relevant to intention and behavior predictions due to the elevated importance of interdependence and community needs (e.g., to promote well-being of, and reduce communicable disease spread in, relevant social groups). Further, we expected larger effects of theory constructs on intentions and behavior in studies with samples recruited from countries with higher HDI scores and lower levels of power distance, as the greater resources, more infrastructural support and services, and fewer economic and social constraints are more likely to scaffold health behavior performance and would be reflected in personal beliefs. By contrast, scarcity in resources, less support and services, and more economic and social constraints are likely to function as de facto constraints and barriers and likely serve to inhibit behavioral performance, similarly reflected in an

individual's beliefs and their effects on intention and health behavior performance (e.g., Boer & Fischer, 2013).

Our final set of moderators focus on additional methodological characteristics: time lag in construct measurement and type of behavior measure employed by studies (self-report vs. non-self-report measures). We expected larger model effect sizes in studies reporting a shorter, more proximal, time lag between measures of social cognition constructs and follow-up behavior measures relative to those adopting a longer, more distal, lag (HM11). Conceptually, a distal lag may attenuate effect sizes between constructs and behavioral outcomes in social cognition theory tests due to the greater likelihood of additional information arising between measurement occasions that leads individuals to modify their beliefs (Ajzen, 1991). We also predicted differences in model effect sizes across studies adopting self-report behavioral measures and those adopting non-self-report measures (HM12). Self-report measures may be associated with biases, such as recall and affirmation bias, which may introduce additional error variance to effect size estimates. We did not specify a direction for this moderator as error associated with self-report measure use may inflate or attenuate effect size estimates.

Finally, we controlled for the potential effects of additional study characteristics by including them as covariates in our model tests. Specifically, we controlled for sample age and sex distribution, sample type including clinical (clinical vs. non-clinical participants) and student (student vs. non-student participants) status, study design (cross-sectional vs. longitudinal), and study quality.

Method

Search Strategy

A systematic search of digital databases (PsycInfo, Web of Science, and PubMed) was conducted in September 2021, with a complimentary search in April 2022 for studies published in languages other than English, to identify eligible research studies for inclusion in the current analysis. Studies were located using keyword search terms developed in accordance with database search standards. Search terms for each database are presented in Supplement S3. In addition, we conducted manual searches of the reference lists of prior meta-analytic reviews of the theory (Floyd et al., 2000; Milne et al., 2000), and studies citing the Rogers (1975) original article introducing the theory through the Web of Science database. Finally, we contacted prominent authors in the field and posted calls to the email listservs of psychological and behavioral medicine societies for unpublished data in October 2024.

Inclusion and Exclusion Criteria and Study Selection

We systematically screened research articles identified in our searches for their eligibility for inclusion in our analysis. Articles were eligible for inclusion if they reported quantitative effect size data between at least one construct from protection motivation theory, a measure of protection motivation, and/or a concurrent or follow-up measure of health behavior. Studies adopting quantitative designs including, but not limited to, cross-sectional or longitudinal correlational designs and intervention or experimental designs, were eligible for inclusion. Studies adopting case study, review, n-of-1, and qualitative designs as well as studies on participants with clinical mental health conditions that may interfere with their ability to respond to survey measures were excluded. Our searches yielded an initial pool of 5,206 research articles after duplicate removal.

Six members of the research team subsequently screened the titles and abstracts of the initial pool of articles to assess their eligibility for inclusion, with good agreement among team members on a sub-sample of double-screened articles (average agreement = 88.00%; average Gwet (2008) AC1/AC2 agreement statistic = 0.807, $p < .001$). Inconsistencies were resolved through discussion and consensus among team members. Four members of the team screened the full text of the retained articles against the inclusion criteria, with good agreement on double-screened articles (average agreement = 90.00%; average Gwet (2008) AC1/AC2 agreement statistic = 0.873, $p < .001$), resulting in a final sample of 214 articles eligible for inclusion. In addition, 35 of the final pool reported data from multiple samples which were treated as independent studies, leading to a final sample of 249 studies included for analysis. Search terms (Supplement S3), databases and a PRISMA diagram summarizing the flow of research items through our screening and selection procedures with exclusion justifications at each stage (Figure S3.1, Supplement S3), a table summarizing studies with multiple samples, construct measures, and behavior measures (Table S4.1, Supplement S4), and a list of the included studies (Supplement S5) are presented in the supplemental materials.

Construct and Behavior Classification

Included studies in our analysis employed multiple measures to assess protection motivation theory constructs and health behavior. We developed and implemented a systematic procedure to ensure uniformity in construct and behavior measure definitions used across the included studies consistent with protocols used in previous work (e.g., McAnally & Hagger, 2023). The procedure involved developing initial a priori definitions of protection motivation theory variables and health behavior with associated representative items based on prior research and original conceptualizations of the theory (Maddux & Rogers, 1983; McMillan & Conner, 2007; Rogers, 1975). Definitions were developed by two members of the research team with area expertise working collaboratively to arrive at a consensus for each definition. The classification procedure required assigning measures of each construct and behavior employed in the included studies to construct and behavior categories based on their match with the developed definitions. Importantly, the matching procedure focused on the item content of the measures used in each study rather than the label assigned to the constructs by the study authors. During application of the construct classification procedure, an insufficient number of the included studies were found to measure maladaptive coping, precluding inclusion of this construct in our analyses. However, we elected to classify measures traditionally defined as maladaptive response rewards as a proxy measure for maladaptive coping for the purposes of our analyses based on their conceptual similarity (Self & Rogers, 1990; Van Der Velde & Van Der Pligt, 1991). However, it should be stressed that there is a paucity of evidence examining associations between maladaptive response rewards and endorsement of maladaptive coping responses, precluding assessment of empirical overlap in these constructs. Details of our definitions, sample items, and classification procedure are provided in Table S6.1 (supplemental materials, S6).

Effect Size Data Extraction

We extracted zero-order correlation coefficients between measures of constructs from protection motivation theory, protection motivation, and behavior from each included study. When zero-order correlations were unavailable or unreported, wherever possible, we extracted other effect size data (e.g., unadjusted odds ratio, Cohen's d) or

data allowing computation of an effect size (e.g., means and standard deviations, t-values) and converted these data to a zero-order correlation coefficient using standard formulae (Borenstein et al., 2009; Digby, 1983)[7].

Most of the included studies adopted correlational designs, either measuring theory constructs and outcomes cross-sectionally at a single time point, or longitudinally at two or more time points. Few studies adopted experimental or intervention designs, and none reported manipulating or intervening to change a construct from protection motivation theory and testing its effect on a pertinent outcome (e.g., another construct from the theory, or a measure of protection motivation or intention or health behavior). These studies were, therefore, treated as correlational in design, and data collected at baseline prior to administration of the manipulation or intervention, or data from a control group, were extracted for effect size calculations to obviate any influence of the extraneous manipulation or intervention components. In addition, we extracted data on sample demographic characteristics (mean age and standard deviation, gender distribution), measurement lag across data collection occurrences in longitudinal studies, study design, details of measures used to evaluate protection motivation theory constructs, protection motivation, and behavior, and the category and operationalization of measured behaviors. A table summarizing the characteristics of each included study is provided in Table S7.1 (supplemental materials, S7).

Moderator and Covariate Coding

We coded studies according to several candidate moderators expected to affect relations among protection motivation theory constructs, protection motivation, and behavior, and examined the effects of these moderators on model effects in the truncated version of our proposed model. Our moderator variables were: measurement validity, perceived susceptibility measure type, measurement correspondence, health behavior type, cultural orientation, HDI score, parasite stress, power distance, tightness-looseness, flexibility-monumentalism, measurement lag, and behavior measure type. In addition, we coded several sample and methodological characteristics for inclusion as covariates in our analyses: sample age distribution, sample sex distribution, sample type (clinical and student status), study design, and study quality. Moderator and covariate coding is summarized in Table S7.1 (supplemental materials, S7).

Moderator Variables

Measurement validity. We classified studies as those employing validated measures if they provided statistical (e.g., internal consistency statistics, confirmatory factor analysis) or narrative (e.g., pilot testing of measures, reports of user engagement in measurement development) evidence of validity or reliability of protection motivation theory constructs. Studies were classified as using non-validated measures if they did not report validity or reliability evidence. Only a few studies were classified as using non-

[7]To ensure uniformity in effect size calculations and subsequent analyses, we ensured that extracted data were expressed with the conceptually-appropriate sign. For example, correlation coefficients for measures of response costs or maladaptive coping with other constructs and outcomes were expected to be positive in sign when measures used for these constructs were operationalized as high scale values corresponding to low levels on the construct to be consistent with theory predictions. When correlations deviated from this expected pattern (e.g., high scale scores on measures of response costs negatively correlated with protection motivation for a health-promoting behavior), their signs were reversed during extraction. Therefore, response costs and maladaptive coping were expected to be positively correlated with other theory constructs and outcomes in our analyses.

validated measures, which resulted in empty cells in the input correlation matrix and precluded a model test. As a compromise, we performed a sensitivity analysis in which we compared effects from the model estimated in studies with evidence of measurement validity with those from the model estimated in the full sample. This enabled us to evaluate whether excluding data from studies using non-validated measures led us to alter our conclusions with respect to model effects.

Perceived susceptibility measure type. Studies were coded as adopting conditional measures of perceived susceptibility if they prompted participants to evaluate their risk of developing a health issue if they did not perform a precautionary behavior (e.g., "If you do not quit smoking, how likely do you think it is that you will develop lung cancer?"), or if they initiated, or continued to perform, a risk behavior (e.g., "If you continue to smoke cigarettes, how likely do you think it is that you will develop lung cancer?"). Studies were coded as adopting unconditional measures of perceived susceptibility if they prompted participants to evaluate their risk of developing a health issue without specifying a precautionary or risk behavior of reference (e.g., "How likely do you think it is that you will develop lung cancer?").

Measurement correspondence. We applied a consensus-based classification procedure in which two members of the research team coded included studies according to whether or not items comprising the protection motivation theory measures adopted made explicit reference to the target health behavior and the context in which it was performed. Studies were coded high in correspondence if measure items clearly satisfied both criteria, while studies were coded low in correspondence if items did not clearly match the target behavior and the context. For example, studies were coded as low in correspondence if a self-efficacy measure made only general reference to the behavior (e.g., COVID-19 protective behaviors) while the measure of protection motivation or behavior measure focused on a specific behavior (e.g., COVID-19 vaccination). Finally, studies were coded as having nil correspondence if items did not match the target behavior. For example, studies adopting a general self-efficacy scale (e.g., Luszczynska et al., 2005) that made no reference to a specific behavior were coded as having nil correspondence. Studies in the nil and low measure correspondence categories were grouped together to form a binary moderator variable for analysis.

Health behavior type. We coded studies into two broad categories of target behaviors consistent with prior meta-analyses of social cognition theories (Hagger & Hamilton, 2025; R. R. C. McEachan et al., 2011): health promotion or health risk behaviors. Studies were classified as targeting health promotion behaviors if the behavior was expected to promote prevention of illness or disease, assist in the management of a health threat, or improve health outcomes such as quality of life and psychological well-being (e.g., physical activity, fruit and vegetable consumption). Studies were classified as targeting health risk behaviors if the behavior was considered likely to result in harmful effects to health or reduced well-being, or increase illness or disease risk (e.g., smoking, alcohol binge drinking).

Country-of-origin characteristics. We coded included studies according to a panel of candidate moderators representing key economic, ecological, and cultural characteristics of the country-of-origin of the sample informed by previous research (see Fischer et al., 2024): cultural orientation (individualism-collectivism), HDI score, parasite stress, power distance, tightness-looseness, and flexibility-monumentalism.

Cultural orientation. Individualism-collectivism is a widely established facet of cultural difference that describes individualist societies as more motivated by personal beliefs and independence, and collectivist societies as more motivated by social norms and interdependence (Triandis, 2018). We used national normative data based on Hofstede's Individualism index (Hofstede, 2001) to classify study country-of-origin into collectivist (Individualism index score < 50) and individualist (score ≥ 50) categories.

HDI score. HDI is a measure of overall level of national health, education, and standard of living. Study country-of-origin was classified into low, medium, high, and very high HDI categories according to HDI scores published in the 2023-2024 Human Development Report (United Nations Development Programme [UNDP], 2024). We grouped studies classified as low, medium, and high HDI scores into a single category, with those classified as very high as a single category, to form a binary moderator variable.

Parasite stress. We classified studies according to country-level parasite stress, which describes the prevalence of parasites likely to harbor disease or illness in the study country-of-origin. Study country-of-origin was coded into low and high parasite stress categories if their disease prevalence was lower or higher, respectively, than the global mean (Murray & Schaller, 2010).

Power distance. Power distance refers to the extent to which social relations are more egalitarian (low power distance) or hierarchically organized (high power distance), and the extent to which this inequality is accepted within a society. Study country-of-origin was coded into lower (scores 1-40), middle (scores 41-80), and upper (scores 81-120) categories based on scores on Hofstede's power distance index (Hofstede, 2001). Studies in the mid and upper power distance categories were grouped into a single high category with those classified as lower in a single category to form a binary moderator variable for analysis.

Tightness-looseness. Tightness-looseness describes the extent to which behaviors are more controlled or guided by normative influences in a society, and whether behavioral transgressions from the norm are more ("looser" societies) or less tolerated ("tighter" societies). We coded study country-of-origin into upper (scores 81-120), mid (scores 41-80), and lower (scores 0-40) categories based on national scores on the Combination Index of Cultural Tightness-Looseness (Uz, 2015).

Flexibility-monumentalism. Flexibility-monumentalism refers to the extent to which a society tends to endorse adaptability, personal flexibility, and lower self-regard (high flexibility) or consistency, pride, and stability (high monumentalism; Minkov, 2011; Minkov et al., 2018). We coded study country-of-origin into lower (rank #37-54), mid (rank #19-36), and upper (rank #1-18) categories based on national rankings on flexibility-monumentalism (Minkov et al., 2018).

Measurement lag. We also classified included studies employing longitudinal designs according to the temporal lag between measures of theory constructs and measures of behaviors (e.g., Hagger & Hamilton, 2024; McEachan et al., 2011). However, there were too few effect sizes to estimate our model in the distal category precluding a formal moderator analysis or meaningful sensitivity analysis.

Health behavior measure type. We coded studies according to whether they adopted self-report measures of behavior or non-self-report measures (e.g., wearable accelerometers for physical activity measurement, recorded attendance of physical therapy appointments). As with measurement lag, there were too few effect sizes in the

non-self-report category to estimate our model, rendering a formal moderator or sensitivity analysis redundant.

Covariates

We controlled for the following covariates in our model tests: sample age and sex distribution, sample types (clinical vs. non-clinical, student vs. non-student), study quality, and study design. For sample age distribution, study samples were classified as younger if the average sample age was 40 years or below with a standard deviation of less than 15, if greater than 70% of the sample was younger than 40, or if the upper limit of the sample age range fell below 40 years. Studies were classified as older if the average sample age was 40 years or above with a standard deviation of less than 15, if greater than 70% of the sample was older than 40, or if the lower limit of the sample age range fell above 40 years. Finally, studies were classified as balanced in distribution if the sample age range fell outside of these parameters. With respect to sex distribution, study samples were classified as either majority women or majority men if 75% or more, or 25% or less, respectively, of sample participants identified as female, and all other samples were classified as balanced. Studies were classified as cross-sectional in design when data were collected on a single occasion, and longitudinal in design when data were collected across multiple occasions. Quality of included studies was assessed using the Quality Assessment Checklist for Survey Studies in Psychology (Q-SSP; Protogerou & Hagger, 2020), a 20-item checklist designed to rate study quality in four categories: study rationale and variable measurement, data collection and analysis, discussion of results, and ethical review. Quality assessment was conducted by two members of the research team with prior experience in using the Q-SSP checklist to evaluate study quality with good agreement across members on independent assessment of a sub-sample of studies across items (average agreement = 90.00%; average AC1/AC2 = 0.832, median $p < .001$) and overall score ($R = 0.784$, $p < .001$). Identified inconsistencies in the application of the scoring criteria were resolved through discussion and procedures amended accordingly and applied to the entire sample of studies. Consistent with Q-SSP guidelines, studies were coded as acceptable in quality if they obtained a checklist score of 75% or higher and questionable if they obtained a score of less than 75%. Study quality codes for included studies are reported in Table S7.1 (supplemental materials, S7) and the Q-SSP checklist and scoring guide are presented in Supplement S8.

Data Analysis

Multi-Level Meta-Analytic Structural Equation Models

Averaged correlations among protection motivation theory constructs and health behavior, and hypothesized theory-implied effects of our full and truncated versions of our proposed models, across studies were estimated using Wilson et al. 's (2016) multi-level implementation of Cheung's (2015) two-stage meta-analytic structural equation modeling procedure. In the first stage, we used random effects multivariate multi-level meta-analysis to produce a pooled correlation matrix among constructs from the proposed model corrected for sampling error, which also enabled us to account for dependency among constructs and adjust for our covariates using Wilson et al.'s procedure. This stage produced averaged correlation coefficients and variability estimates among theory constructs, along with the two indices of model heterogeneity: Cochran's Q and I^2 statistics. A statistically significant Q value and an I^2 value over 25% were considered indicators of substantive heterogeneity between studies. In the second stage, our proposed models were fit to the pooled correlation matrix. For each model, the analysis yielded a

panel of statistics assessing overall model fit and standardized parameter and variability estimates for each model effect. As the model goodness-of-fit chi-square is typically oversensitive to misfit, we used the comparative fit index (CFI), Tucker-Lewis index (TLI), the standardized root mean square of model residuals (SRMSR), and root mean square error of approximation (RMSEA) and its 95% confidence interval to evaluate model fit. Values approaching or exceeding 0.95 for the CFI and TLI, less than .05 for the SRMSR, and less than 0.08 with narrow confidence intervals were considered indicative of good model fit, consistent with guidelines (Hu & Bentler, 1999). Parameter estimates were deemed non-zero if the 95% confidence interval did not contain zero. Missing data were imputed using the full information maximum likelihood estimation method. For both models estimated in stages 1 and 2, we used model selection criteria for non-nested models, Akaike's Information Criterion (AIC) and its Bayesian implementation (BAIC), to assess effects of covariates – models with substantively lower AIC and BAIC values were considered most optimal in parsimony. Analyses were conducted in R using the metafor (Viechtbauer, 2010) and metaSEM (Cheung, 2015) packages.

Analysis of Moderators

Effects of candidate moderators on the hypothesized effects of our truncated model of protection motivation were tested by estimating the model separately in groups of studies at each level of the moderator. Differences in the standardized parameter estimates of hypothesized model effects across moderator groups were tested using the confidence interval about the parameter estimate difference (Schenker & Gentleman, 2001)[8].

Assessment of Bias

We assessed potential for small-study bias, often attributed to publication bias, for each pooled correlation among study constructs from our meta-analysis using a panel of recommended bias analyses (Carter et al., 2019). One set of analyses were broadly based on 'funnel' plots of each study effect size on a precision estimate (e.g., the inverse of the standard error): the rank correlation test, 'trim and fill' analysis, and regression tests including two variations, the precision effect test (PET) and the precision effect estimate with standard error (PEESE). Another set was based on selection models: a variation on the original selection model and two recent implementations, the *p*-curve and *p*-uniform* analyses. A full description and criteria for evaluation for each analysis is presented in supplement S9 (supplemental materials).

Results

Multilevel Multivariate Meta-Analysis of Correlations

Averaged bias-corrected zero-order correlations among model constructs, protection motivation, and behavior from the stage 1 multilevel multivariate meta-analysis of the full and truncated versions of protection motivation theory, unadjusted and adjusted for covariates, in the complete sample of studies are presented in Tables S10.1 and S10.2 (supplemental materials, S10) with corresponding variability and heterogeneity estimates presented in Table S10.3 (supplemental materials, S10). For the full version of the model, correlations among the threat and coping appraisal constructs, protection

[8]Studies that could not be definitively assigned to a single moderator category (e.g., studies reporting data comprising participants from multiple countries), or studies that were not relevant to a particular moderator analysis (e.g., studies that did not measure perceived susceptibility) were omitted from the analysis for the relevant moderator.

motivation, and behavior were non-zero and small-to-medium in size, consistent with our hypothesis (HC1). Similarly, correlations between the appraisal constructs and maladaptive coping were also non-zero and small in size, the correlations of fear and response efficacy with maladaptive coping excepted, providing partial support for our hypothesis (HC2). The meta-analytic models were associated with substantive heterogeneity, indicated by non-zero Q values and I^2 values surpassing 25%. Correlations among constructs for the truncated version of the model mirror the pattern observed for the full model: averaged correlations among constructs were also non-zero, small-to-medium in size with substantive heterogeneity. The AIC and BAIC model selection criteria indicated only minor differences across the covariate-adjusted and unadjusted models in all cases.

Multilevel Meta-Analytic Structural Equation Models

Full Model Analyses

In stage 2 of our analysis, we fit our proposed full version of the model to the pooled matrices of average bias-corrected correlations from the multi-level multivariate meta-analysis in the complete sample of studies. Model parameter and variability estimates are presented in Table 1 and model fit statistics summarized in Table S11.1 (supplemental materials, S11). Unadjusted and covariate-adjusted versions of the model exhibited good fit with the data according to adopted criteria[9]. As with the models estimated in stage 1, differences in AIC and BAIC values across the unadjusted and covariate-adjusted models were modest with an identical pattern of effects. We subsequently focus on parameter and variability estimates for the unadjusted models for our hypothesis tests and report adjusted estimates for comparison in our supplement.

As predicted, we observed non-zero small-sized direct effects of each threat (perceived susceptibility, HF1; perceived severity, HF2; fear, HF3) and coping (self-efficacy, HF4; response efficacy, HF5; response costs, HF6) appraisal construct on protection motivation, and of the response costs (HF13) and self-efficacy (HF14) constructs on maladaptive coping. We also found non-zero direct effects of protection motivation (HF8) and self-efficacy (HF9), as expected, on health behavior, with medium and small effect sizes, respectively. However, effects of perceived susceptibility (HF10), perceived severity (HF11), fear (HF12), and response efficacy (HF15) on maladaptive coping, and of maladaptive coping on protection motivation (HF7), were no different from zero. We also noted consistently larger effect sizes for the effects of coping and self-efficacy constructs on protection motivation and maladaptive coping, and in the corresponding total sums of indirect effects of these constructs on health behavior, relative to the sizes of the effects of threat appraisal and fear constructs, which were confirmed in a series of follow up tests of difference using confidence intervals about the mean difference (Schenker & Gentleman, 2001). These findings are presented in Table S11.2 (see supplemental materials). Specifically, direct effects of coping appraisal and self-efficacy constructs on protection motivation were larger than those for threat appraisals and fear in all cases, differences in effects of response costs with effects of perceived susceptibility and fear on protection motivation excepted. We also observed an

[9]A caveat is that TLI values for the full model fell slightly short of recommended cutoff criteria. We note that this is likely function of the inherent penalty this index imposes on models with low parsimony, which may be an over-stringent and analysts recommend that consider model fit and parsimony should be considered independently (Williams & Holahan, 1994).

analogous pattern of differences for effects of these constructs on maladaptive coping, the effects of self-efficacy with perceived susceptibility and severity on maladaptive coping excepted. In addition, the sums of indirect effects of coping appraisals mediated by protection motivation was larger than that for threat appraisals, but we observed no differences in total effects of coping and threat appraisals on health behavior mediated by maladaptive coping responses.

Also consistent with our hypotheses, we observed small-sized non-zero specific indirect effects of each threat (HF16) and coping (HF17) appraisal construct on behavior mediated by protection motivation. However, specific indirect effects of each appraisal construct on behavior mediated by maladaptive coping were no different from zero (HF18, HF19). Taken together, this translated to non-zero sums of indirect effects of the set of threat and coping appraisal constructs on behavior mediated by protection motivation. Finally, we observed a medium-sized total appraisal-behavior effect, which represented the cumulative indirect effects of the set of threat and coping appraisal constructs on behavior mediated by both protection motivation and maladaptive coping (HF20). Overall, both versions of the model explained non-trivial variance in maladaptive coping, protection motivation, and behavior (see Table S11.1, supplemental materials, S11).

Truncated Model Analyses

Fit indices for the truncated version of the model and parameter and variability estimates for model effects are presented in Table S11.1 (supplemental materials, S11) and Table 2, respectively. The CFI and TLI fit indices fell below adopted cutoff criteria for good model fit, indicative of model misspecification. We subsequently modified and re-estimated our model to include a direct effect of coping appraisals on behavior (HT6.1). Our basis for the inclusion of the direct effect was derived from prior primary and meta-analytic studies (e.g., McEachan et al., 2011; Rich et al., 2015) reporting non-zero direct effects of control-related constructs such as perceived behavioral control and self-efficacy on behavior. These effects are conceptually consistent with the contention that when perceived and actual control align, control-related constructs should predict behavior directly (e.g., Ajzen, 1991). We also noted conceptual work indicating alignment of self-efficacy with other coping appraisal constructs (response efficacy and response costs) from the theory[10], as corroborated by the non-zero averaged correlations among these constructs in the current analysis. We therefore reasoned that inclusion of a direct coping appraisal-behavior effect in our truncated model in the current analysis represented a conceptually sound and empirically-supported revision. As expected, unadjusted and covariate-adjusted versions of the respecified model exhibited good fit with the data according to adopted criteria, and we took this version of the model as final.

Turning to our hypothesis tests, we observed non-zero positive effects of threat (HT1) and coping (HT2) appraisals on protection motivation, of maladaptive coping on protection motivation (HT3), of coping appraisals on maladaptive coping (HT5), and of protection motivation (HT6) and coping appraisals (HT6.1) on behavior with small-to-medium effect sizes. However, the direct effect of threat appraisals on maladaptive coping (HT4) was no different from zero. In addition, we observed small-sized non-zero positive sums of indirect effects of threat and coping appraisals on behavior mediated by

[10]It is important to note that the same conceptual and empirical research formed the basis for subsuming the self-efficacy construct under the coping appraisal construct in our truncated model.

protection motivation alone (HT7), and by both protection motivation and maladaptive coping (HT8). We note that the sums of indirect effects for threat appraisals could be predominantly attributable to the specific indirect effect of threat appraisals mediated by protection motivation. We also observed a non-zero total effect of coping appraisals on behavior comprising the direct effect and the indirect effect mediated by protection motivation, with a medium effect size. Both versions of the model accounted for non-trivial variance in protection motivation, behavior, and maladaptive coping.

Moderator Analyses

Effects of our moderator variables on protection motivation theory effects were tested by estimating our final truncated version of the model in data from groups of studies at each level of the moderator. As before, we focused on the unadjusted versions of the model given the modest differences in model selection criteria and in the pattern of effects across the unadjusted and covariate-adjusted versions of the model[11]. Model variability and heterogeneity estimates, fit indices, and standardized parameter and variability estimates with formal difference tests for the truncated model estimated in groups of studies at each level of each moderator are presented in Table S10.3, Table S11.1, and Tables S12.1 to S12.10 (supplemental materials, S10, S11, and S12), respectively. Next, we summarize the notable observed differences in model parameter estimates from the moderator analyses. It is important to note that although the results of our moderator analyses outlined in the following sections flag salient differences in model effects according to relevant contextual, methodological, and measurement characteristics, they did not entirely resolve the overall observed heterogeneity in the model, and substantive residual heterogeneity remained in each moderator group (see Table S10.3, supplemental materials).

Measurement validity. Our sensitivity analysis comparing effects of the model estimated in groups of studies providing evidence supporting the validity of study measures to effects of the model estimated in the full sample of studies identified no notable differences, contrary to hypotheses (HM1).

Perceived susceptibility measure type. We noted larger direct effects coping and threat appraisals on maladaptive coping, and of maladaptive coping on protection motivation, in groups of studies adopting conditional measures of perceived susceptibility relative to those adopting unconditional measures, supporting our hypothesis (HM3). By contrast, the direct effect of coping appraisals on protection motivation was larger in studies adopting unconditional susceptibility measures compared to those adopting conditional measures. In addition, we observed larger indirect effects of threat and coping appraisals mediated by both maladaptive coping and protection motivation, and a smaller indirect effect of coping appraisals on behavior mediated by protection motivation, in studies adopting conditional susceptibility measures relative to those adopting unconditional measures. However, this combination of direct and indirect effects meant

[11]We noted substantive differences in the number of available studies and, as a consequence, sample sizes when estimating our model at some levels of our moderator variables. This increased the likelihood of disproportionately larger effects of our covariates on model parameter estimates for models estimated in the moderator group with the smaller sample size, with the potential to bias or mask moderator effects. We therefore focused our moderator comparisons on the unadjusted models. Finally, to ensure that the covariates did not have substantive moderating effects on proposed theory effects, we conducted ancillary analyses with each covariate as a moderator and compared model effects across levels of each. These analyses are reported in supplement S13.

there were no differences in the sums of indirect effects and total effects of the appraisal constructs on behavior.

Measurement correspondence. Consistent with predictions (HM2), we observed larger direct effects of coping appraisals on protection motivation and maladaptive coping, and of protection motivation on behavior, in studies demonstrating high correspondence in theory construct and outcome measures relative to studies with low or nil correspondence of psychological construct measures to their outcome measures. We also observed larger indirect effects of threat and coping appraisals on behaviors mediated by protection motivation, effects which translated into larger sums of indirect and total effects of these constructs on behavior in studies demonstrating high correspondence.

Health behavior type. As predicted (HM4), we observed larger direct effects of coping appraisals on protection motivation and behavior, larger indirect effects of coping appraisals on behavior mediated by protection motivation, and larger sums of indirect effects and total effects of coping appraisals on behavior, in groups of studies targeting health-promoting behaviors compared to those targeting health risk behaviors. By contrast, we observed a larger direct effect of maladaptive coping on protection motivation, and larger indirect effects of coping appraisals on behavior mediated by both maladaptive coping and protection motivation, in studies targeting health risk behaviors relative to those targeting health-promoting behaviors.

Cultural orientation. We noted non-zero differences in theory effects according to levels of individualism-collectivism, supporting our expectations (HM5). Specifically, analyses revealed larger direct effects of coping appraisals on maladaptive coping and protection motivation, and larger indirect effects of coping appraisals on behavior through protection motivation, in groups of studies comprising samples classified as individualist relative to those comprising samples classified as collectivist. This was reflected in larger sums of indirect effects of coping appraisals on behavior in studies comprising individualist samples compared to those comprising collectivist samples.

HDI score. In groups of studies targeting samples with very high HDI scores, we observed larger direct effects of coping appraisals on maladaptive coping compared to groups of studies targeting samples with low, medium, and high HDI scores, in line with our expectations (HM6).

Parasite stress. Consistent with our expectations, we found non-zero differences in effects across studies according to parasite stress level (HM7). Specifically, we observed larger direct effects of coping appraisals on protection motivation, and larger indirect effects of coping appraisals on behavior mediated by protection motivation, in groups of studies comprising samples with low parasite stress relative to groups of studies on samples with high parasite stress.

Power distance. Our moderator analyses revealed non-zero differences in theory effects according to power distance levels of the study sample, as expected (HM8). We noted a larger direct effect of coping appraisals on maladaptive coping in groups of studies comprising samples classed as low in power distance relative to studies on samples classed as mid and upper on power distance.

Tightness-looseness. We observed larger direct effects of maladaptive coping on protection motivation in groups of studies targeting samples classified in the upper and mid levels of tightness compared to studies on samples classed as low in tightness, and of coping appraisals on maladaptive coping and protection motivation in studies with mid

and upper levels of tightness, respectively, compared to studies on samples with low levels of tightness. In addition, the indirect effect of coping appraisals on behavior mediated by both maladaptive coping and protection motivation was larger in groups of studies on samples with mid levels of tightness compared to those on samples with low levels of tightness. The direct effect of protection motivation on behavior, indirect effect of coping appraisals on behavior through both maladaptive coping and protection motivation, sums of indirect effects of threat appraisals on behavior, and the correlation between threat and coping appraisals were larger in studies targeting samples with mid levels of tightness relative to those targeting samples with upper levels of tightness. By contrast, the direct effects of coping appraisals and maladaptive coping on protection motivation, and the indirect effect of coping appraisals on behavior mediated by protection motivation, were larger in studies on samples with upper levels of tightness compared to studies on samples with mid levels of tightness. Overall, these findings were partially consistent with our expectations (HM9).

Flexibility-monumentalism. In line with expectations (HM10), we observed larger direct effects of coping appraisals on maladaptive coping and maladaptive coping on protection motivation, and larger indirect effects of coping appraisals on behavior mediated by both maladaptive coping and protection motivation, in groups of studies comprising samples classified as mid ranked in flexibility-monumentalism relative to studies comprising samples classified as lower and upper ranked in flexibility-monumentalism. Similarly, we observed larger direct effects of coping appraisals on maladaptive coping in studies on samples with upper ranking on flexibility-monumentalism compared to studies on samples with lower ranking on flexibility-monumentalism.

Bias Assessment

Results from our panel of bias analyses are presented in Table S15.1 (supplemental material, S15). Overall, results from each analysis indicated little evidence of systematic bias in synthesized effect sizes in the current analysis save some minor idiosyncratic instances. In addition, reproduced effect sizes were generally in line with naïve (uncorrected) effect sizes in the vast majority of cases[12].

Discussion

In the current meta-analysis, we tested protection motivation theory hypotheses across studies applying the theory in health behavior contexts and tested the effects of salient conceptual, methodological, and contextual moderating variables on which theory effects were expected to be conditional. Specifically, we tested theory-implied unique direct and indirect effects of theory constructs on protection motivation and health behavior using meta-analytically synthesized data from applications of the theory in health behavior contexts located in a systematic database search. Model effects were also estimated separately and differences compared in groups of studies defined at levels of our moderator variables: measurement validity, perceived susceptibility measure type, measurement correspondence, parasite stress, socioeconomic, cultural dimensions related to sample country-of-origin (HDI score, individualism-collectivism, power distance,

[12]A caveat to our conclusion of minimum bias is that all analyses were conducted using aggregated effect sizes and with the assumption of low heterogeneity. Implementations of these analyses for use with a multi-level meta-analytic model and under an assumption of substantive heterogeneity are required.

tightness-looseness, flexibility-monumentalism), measurement lag, and behavior measure type.

Well-fitting meta-analytic structural equation models specifying theory effects provided support for the predicted pattern of effects. Specifically, we observed non-zero, small-to-medium sized correlations among theory constructs, and non-zero direct and indirect effects for theory-implied relations, among the appraisal constructs, protection motivation, and behavior with few exceptions. Moderator analyses revealed conceptually consistent differences in the theory effects across levels our proposed moderators. In the next sections, we discuss our findings in light of prior primary research and meta-analyses and their contribution to theory development and future theory tests in health behavior contexts, outline limits of, and caveats to, our analysis, and suggest recommendations for future research.

Implications of the Theory Test

Although it is notable that the meta-analytically synthesized correlations among protection motivation theory constructs observed in our current analysis were both conceptually-consistent and in close alignment with those observed in previous meta-analyses (Floyd et al., 2000; Milne et al., 2000), the headline contribution of our analysis is the provision of robust estimates of the unique effects of theory constructs on protection motivation theory constructs and health behavior across studies, and enabled tests of hypothesized indirect effects of appraisal and maladaptive coping on health behavior mediated by protection motivation. The latter, therefore, provides support for key theory-implied effects, particularly unique construct effects and candidate proposed mediation mechanisms, and also mirrors received analytic approaches used to test theory effects in primary research studies and moves on from the strictly univariate approach adopted in previous meta-analyses (see Balla & Hagger, 2025). With respect to the unique effects of theory constructs in our model test, the prominence of both threat and coping appraisals, the latter encompassing not only response efficacy and costs but also self-efficacy, as unique predictors of protection motivation, and, importantly, as indirect effect predictors of health behavior, lends support to their original specification in the theory as independent, salient considerations that individuals take into account when making decisions to perform health behaviors and their subsequent behavioral engagement. Further, that direct effects of coping appraisal constructs on protection motivation were larger than effects for threat appraisal constructs, which also translated to larger sums of indirect effects of coping appraisals, relative to threat appraisals, mediated by protection motivation is also noteworthy. This is consistent with prior research highlighting the salience of constructs closely aligned with coping appraisal constructs, particularly the burgeoning evidence for effects of self-efficacy and attitude, the latter construct akin to response efficacy and cost perceptions from the theory, on intention and, indirectly, behavior in health behavior contexts (Hagger, 2025; Hagger & Hamilton, 2024; McEachan et al., 2011, 2016). These findings signal the prescience of these appraisals as those that are most heavily implicated in decisions to engage in health behaviors broadly, as well as the prominent role they occupy as key targets for intervention (e.g., Sheeran et al., 2016; Steinmetz et al., 2016). However, the smaller effect size for threat appraisals coupled with the general conceptual and empirical recognition suggesting a smaller independent role for these beliefs in health behavior prediction (e.g., Zhang et al., 2019) notwithstanding, our analysis indicates that the role of threat perceptions should not be considered trivial or redundant. These perceptions

nevertheless account for a unique, albeit modest, proportion of the variance in protection motivation and health behaviors (e.g., Brewer et al., 2007) and, importantly, have been shown to be efficacious as targets in behavioral interventions, particularly for risk-related behaviors (e.g., Peters et al., 2013).

A further unique contribution of the current meta-analysis is the inclusion of maladaptive coping, represented in this study by a proxy measure comprised of items tapping into maladaptive response rewards, as an additional mediator of effects of theory constructs on protection motivation and, in serial mediation with the latter construct, as a mediator of appraisal constructs on health behavior. This advances on prior syntheses of research applying the theory that have, to date, omitted tests of the role of this conceptually salient construct as a health behavior determinant and its role in a key mechanism proposed in the theory. All considered, a reason for this omission may be the hitherto dearth of primary studies that have conducted comprehensive tests of the theory that encompass this construct, precluding synthesis, an issue that has been raised elsewhere (e.g., Balla & Hagger, 2025) and that was encountered in the current analysis. Our findings, therefore, while not measuring the maladaptive coping construct as originally defined in the theory, provide the first attempt at a large sample estimate in the currently available evidence of these critical hypotheses, and, in so doing advance knowledge on theory efficacy by providing robust data of the expected size and variability that researchers might expect when applying the theory in health behavior contexts.

With respect to specific findings for maladaptive coping effects in our full model test, although we accounted for variance in maladaptive coping itself, with the response cost and self-efficacy constructs, and, analogously, both coping and threat appraisals, predicting maladaptive coping in the full and truncated versions of the model, respectively (as observed elsewhere, e.g., Hodgkins & Orbell, 1998)[13], we found no effects of maladaptive coping on health behavior and, as a consequence, it did not function as a salient mediator of theory constructs on behavior as any indirect effects were primarily directed through protection motivation. Although these findings are not in keeping with theory predictions, they align well with trends observed in the broader primary research testing the theory and indicate that maladaptive coping and related beliefs about maladaptive behaviors account only for trivial variance in behavior in a substantive majority of cases (e.g., Lee et al., 2013; Umeh, 2004). These patterns generally align with effects identified for other constructs that represent the behavioral relevance of emotion-focused coping strategies that tend to be adopted in response to health threats, such as venting emotions, wishful thinking, avoidance, or seeking emotional support (e.g., Brown et al., 2005; Hagger et al., 2017; O'Connor et al., 2008).

[13]An adjunct implication of this finding is that coping appraisals are particularly salient relative to threat appraisals when it comes to individuals' adoption of both adaptive responses, in this case represented by protection motivation and, indirectly, health behavior, and maladaptive responses to health threats (e.g., Bigsby & Albarracín, 2022; Sheeran et al., 2016). This may imply that individuals endorsing adaptive coping appraisals likely adopt a raft of coping strategies, some of which may be maladaptive insofar as they are not directly purposed to manage the health threat by behavioral means and, rather, emotion-focused and other strategies aimed at mitigating affective responses. However, arguments have been proposed that adopting such strategies may also facilitate subsequent adoption of strategies that promote behavior change by managing the negative affective responses that may serve to distract or inhibit efforts to engage in problem-focused strategies (Hagger & Orbell, 2022).

While such strategies may assist in mitigating the parallel psychological responses to health threats, such as elevated anxiety and distress, they are not effective in managing the threat itself and mitigating the physical health threat in contrast to active and problem-focused strategies, particularly health behavior participation. Our theory test, therefore, corroborates these findings and illustrates the precedence that protection motivation, as a more adaptive strategy, takes as a determinant of subsequent health behavior. Thus, our findings provide the most robust evidence to date to indicate that, when the theory is tested in full with simultaneous effects of both protection motivation and beliefs related to maladaptive coping, it is the former that is most salient in accounting for variance in individuals' subsequent health behavior participation and the latter has relatively little salience by comparison.

Returning to the issue of determinants of maladaptive coping and protection motivation, it is notable that coping appraisal constructs tended to have larger effects on maladaptive coping than threat appraisals. These findings indicate that coping appraisals are most salient relative to threat appraisals when it comes to individuals' adoption of adaptive responses, in this case represented by protection motivation and, indirectly, health behavior, and reduced use of maladaptive coping strategies and endorsement of rewards related to maladaptive responses in response to health threats (e.g., Bigsby & Albarracín, 2022; Sheeran et al., 2016). Although, elevated perceptions of a health threat would be expected to motivate individuals to adopt strategies, such as emotion-focused coping strategies, to manage the consequential emotional response, it may be that individuals that do not perceive that the target behavior has efficacy in producing outcomes, or do not hold strong beliefs in their personal capacity to perform it, captured in the response efficacy and self-efficacy constructs, are more likely to fall back on maladaptive coping responses. In fact, lower response and self-efficacy may exacerbate negative emotional responses (e.g., anxiety), which may further drive maladaptive coping responses adoption.

Effects of Moderators

While the full sample tests of the theory signal the size and variability of the theory-consistent unique direct and indirect effects that researchers applying the theory in a given health behavior context might anticipate, an inherent auxiliary consideration of the theory and other theories in this class (e.g., Ajzen, 1991; Rosenstock, 1966) is that effect sizes will likely vary in accordance with salient conceptual, methodological, sample-level, and contextual conditions. This is consistent with the original specification of protection motivation theory and other social cognition theories which explicitly state such an expectation, indicating that although proposed effects should hold across conditions, they will likely vary in size reflecting their relative level of contribution to motivational and behavioral outcomes. However, theories have tended not to offer specific predictions with respect to the effects of these moderators, and researchers have since explored their effects in primary studies (e.g., Alhemimah, 2023; Chen et al., 2021; Guo et al., 2015; Schüz, 2017) and research syntheses (e.g., Hagger & Hamilton, 2024; McEachan et al., 2011). Our moderator analyses, therefore, provide tests of salient moderating conditions on theory effects in the currently available data, which contributes evidence relevant to the consistency of the proposed pattern of theory effects regardless of conditions, but also may further inform conceptual knowledge on the conditions under which certain constructs take precedence as health behavior predictors and

methodological and sampling considerations of which researchers applying the theory in future should take into account.

A headline set of moderating effects relate to the type and operationalization of measures used in the study, represented in our measurement validity, perceived susceptibility measure type, and measurement correspondence moderator variables. These moderators have conceptual relevance in that theorists have long indicated the imperative of specificity when operationalizing and measuring constructs representing individuals' internal states (e.g., beliefs with respect to behaviors) and salient outcomes and behaviors (e.g., Wicker, 1969), and this has been frequently cited as a condition for social cognition theories (e.g., Ajzen, 1991) and should apply to protection motivation theory (see Balla & Hagger, 2025). These moderating effects also hold particular relevance for researchers seeking to establish best practices in designing and implementing research to optimally test protection motivation theory predictions insofar as they are assumed to facilitate optimal measurement of the theory's constituent constructs and enhance predictive validity (e.g., Ajzen, 1991; Dixon & Johnston, 2019). That we observed larger-sized effects for key predictors in our theory in studies adopting conditional measures of perceived susceptibility and those adopting construct measures with high measurement correspondence is in line with these conceptual and methodological imperatives. Specifically, studies that closely adhere to measurement practices that emphasize correspondence between construct and outcomes likely tap the target construct with greater precision, that is, are more in keeping with the intended or specific behavioral response (Ajzen, 1991) and those utilizing conditional measures of perceived susceptibility minimize the probability of over- or under-estimating the perceived risk of developing a health threat (e.g., Kaufman et al., 2020). By contrast, non-adherent studies likely utilize measures associated with higher error variance that may attenuate theory effects in this instance (see Balla & Hagger, 2025). Finally, that we found no differences in theory effect sizes in our sensitivity analysis for our measurement validation moderator may imply that effects are relatively robust to issues that may underline measure validity or reliability. However, it may be premature to dismiss the importance of measurement validity and reliability testing as part of robust study design when testing theory effects. We note that even though reporting of evidence of validity or reliability in theory measures was in some cases, very sparse, there is high probability that a vast majority of included studies did utilize items with good measurement validity and reliability but failed to report the relevant validity and reliability evidence. This was corroborated in our construct classification procedure in which we ensured basic conformity of study measures with a priori construct definitions in the included studies, providing some basic quality control on measure face validity. Nevertheless, authors should still be encouraged to conduct and report basic validity (e.g., factor analysis) and reliability (e.g., internal consistency statistics, test-retest reliability) checks on instruments used, consistent with transparency and open science principles.

Alongside the measurement-related moderators, we also considered whether theory effects varied according to the type of behavior targeted in each study. Specifically, consistent with prior meta-analyses of social cognition theories in health contexts (McAnally & Hagger, 2023; McEachan et al., 2011), we tested for differences in model effects in groups of studies targeting health-promoting behaviors and those targeting health risk behaviors. We reasoned that threat appraisals would be more salient considerations with respect to individuals' motivation for health-related behaviors where

risk is likely to be particularly elevated relative to behaviors offering advance protection where the health risks are less immediate, and the health benefits derived from the health behavior itself, and potential maladaptive health outcomes attributable to not acting, are more distal. By contrast, we expected coping appraisals to be more salient to individuals' decisions to participate in protection behaviors given that such behaviors are less likely to evoke visceral emotion-related responses and more likely to require reasoned evaluation of consequences and outcomes. That we observed larger direct effects of coping appraisals on protection motivation, and larger indirect and total effects of this construct on behavior, in groups of studies targeting health promotion behaviors is consistent with the latter prediction. This pattern of results corroborates the notion that behaviors conferring health benefits (e.g., physical activity, clinic attendance) likely necessitate greater deliberation of possible benefits and required resources and capacity to achieve them, reflected in the response efficacy and self-efficacy constructs. Researchers may, therefore, expect coping appraisals to be more prominent behavioral determinants for protection-oriented behaviors, and such data may signpost coping-related variables, such as self-efficacy and response efficacy, as principal targets in experimental tests and interventions studies for these types of behaviors (e.g., Gaston & Prapavessis, 2014; Nezami et al., 2016). Of course, this does not mean that coping appraisals are irrelevant considerations in decisions to perform risky behaviors, but the smaller effects suggest other constructs may be of greater relevance. For example, direct effects of maladaptive coping on protection motivation, and its indirect effect on behavior through protection motivation, were larger in studies targeting health risk behaviors. This corroborates concerns that coping strategies that tend to be ineffective in managing health threats, and more concerned with managing emotional responses to health risks, are more relevant to decisions to engage in risky behaviors. This evidence suggests that researchers should consider investigating means to mitigate maladaptive coping responses for risky behaviors as they are of greater priority for these behaviors (e.g., Rudman et al., 1999).

We also examined the potential effects of contextual conditions based on the characteristics of the country-of-origin of the samples from our included studies on theory effects in our model, specifically, cultural orientation (individualism vs. collectivism), HDI scores, parasite stress, power distance, tightness-looseness, and flexibility-monumentalism. These variables reflect cultural orientations as well as provision of services and resources to populations, which likely serve to inform individuals' beliefs with respect to future performance of health behaviors. In keeping with our expectations, broadly speaking, we found larger effects of theory constructs, particularly effects of coping appraisals in groups of studies targeting samples from countries that endorse individualist cultural perspectives, and in countries likely have greater access to resources (e.g., samples recruited from countries with very high HDI scores), lower average prevalence of parasites and disease (e.g., samples from countries with low parasite stress), lower prevalence and acceptance of inequality (e.g., samples from counties with low power distance), and lower levels of normative restrictions in society (e.g., samples from "looser" and more "flexible" societies). These patterns are consistent with research demonstrating cultural orientation as a moderator of social cognition theory effects and underscore their inception and development in individualistic societies. It may be that socially-relevant and normative considerations take greater precedence in motivating individuals to perform health behaviors in national groups that tend to endorse more collectivist beliefs (e.g., subjective norms in the theory of planned

behavior; e.g., Bagozzi et al., 2001). Our findings also align with previous research examining contextual influences on social cognition constructs as health behavior determinants (e.g., Fischer et al., 2024; Fischer & Karl, 2022; Kim et al., 2022) indicating that individuals in countries with greater resources, support, and services with fewer socio-economic barriers tends may be more likely to endorse beliefs aligned toward future health behavior performance and such beliefs are more consequential to decision-making than individuals from less-resourced countries with fewer resources and more socio-economic constraints. These findings provide salient information on candidate factors that researchers should consider when applying protection motivation theory and may signal particular groups and contexts in which the theory may be more applicable.

Finally, we aimed to examine key methodological factors, specifically, measurement lag and behavior measure type on theory effects. However, a lack of available effect sizes in the distal and the non-self-report moderator groups for the lag and measure type moderators, respectively, precluded moderator or sensitivity analyses. We were therefore unable to conduct analyses analogous to those for these moderators in meta-analyses of other social cognition theories (e.g., Hagger & Hamilton, 2024; McEachan et al., 2011). The paucity of data in these key moderator groups highlights a clear need for data and represents important agenda items for further research applying the theory. For example, studies that employ longitudinal designs taking measures of theory constructs across multiple time points, and those adopting non-self-report behavior measures are necessary for future analytic updates. Such research should be prioritized given evidence signaling the real potential of measurement lag and use of self-report designs to moderate theory effect sizes downwards and introduce error variance in effect estimates, respectively (for a review see Balla & Hagger, 2025).

Contribution, Limitations, and Avenues for Future Research

The current meta-analysis provides a number of noteworthy contributions to current research applying protection motivation theory in health behavior contexts and represents advances on prior syntheses of the theory. First, our analysis is the first to test the unique effects of protection motivation theory constructs on protection motivation and health in synthesized data from available applications of the theory using multivariate data analytic techniques that mirror those in primary test of theory predictions. Thus, in addition to provision of updated associations among theory constructs from the currently available extant research, our findings lend support for proposed patterns of theory effects in a simultaneous test of the theory and posited mechanisms by which the theory constructs relate to behavior, particularly, the mediating role for protection motivation. In addition, our analysis provides support for effects of salient moderator variables that represent conceptual (e.g., behavior type), methodological (e.g., time lag between theory and behavioral measures, study design), sample (e.g., age, gender, student status), and contextual (e.g., country-of-origin characteristics) conditions expected to determine the size of theory effects. Further strengths include the application of evidence-based, rigorous practices for identification of relevant studies, classification of constructs, model estimation, and reporting of findings. The current analysis has value in that it further contributes to an evidence base of potentially modifiable determinants consistent with theory predictions, and offers support for the process-related mechanisms involved, in health behavior contexts and identifies moderators on which its predictions are conditional, both of which are of value to researchers seeking to apply the theory and to informing future experimental and intervention research.

However, we note a series of salient limitations and caveats to our analysis in light of which our finding should be interpreted, namely, our use of a proxy measure of maladaptive coping, limitations in available data that precluded tests the effect of some of our proposed moderator variables on model effects and the likelihood of model effects to vary in accordance with other untested moderators, and the exclusive focus on correlational data.

First, there were insufficient studies reporting tests of relations among the maladaptive coping responses construct, as originally defined in protection motivation theory, and theory constructs. As an alternative, we extracted data on maladaptive response rewards and used this as a proxy measure for maladaptive coping in our test of theory constructs. Although there is a conceptual and empirical precedent highlighting parallels between maladaptive response rewards and maladaptive coping responses, the maladaptive response rewards construct likely does not capture all facets of maladaptive coping (e.g., frequency or intensity of behavioral or cognitive avoidance). As a consequence, current findings do not permit definitive conclusions to be drawn on the pattern of effects for this construct in full compliance with the original specification of the theory and the conceptualization of the maladaptive coping construct. We recommend that researchers prioritize inclusion of all theory constructs, particularly measures of maladaptive coping, and conduct tests of all theory predictions to provide more comprehensive data on the role of maladaptive responses on health behavior performance.

Second, there were insufficient available data in our sample of studies to permit certain moderator analyses, including the behavior measure type and measurement lag moderator variables. Further, there were cases where there were sufficient data to estimate our model in a single moderator group, which precluded a complete moderator analysis and, rather, we were confined to conducting a sensitivity analysis against the model estimated in the full sample of studies, a procedure we adopted for the measurement validity moderator. Given these availability constraints, we encourage the research community to conduct applications of the theory in longitudinal study designs, and to use measures that did not rely exclusively on self-report, which would permit testing of these particular moderators in future syntheses.

Third, while our analyses enable us to test the effects of a broad range of candidate moderators on theory effects, we note the potential for other candidate moderators. For example, we tested the effects of contextual moderators based on study-level differences in sample country-of-origin characteristics, but we recognize the potential for socio-economic indices to vary within samples. However, we were unable to test for the effects of these factors given that participant-level data on indices representing these kinds of conditions or characteristics, such as correlations between theory constructs and education level, income, neighborhood deprivation, and occupational status, were very seldom reported in our included sample of studies. Given research indicated that effects of social cognition theories in health behaviors contexts vary by these indices (e.g., Conner et al., 2013; Schüz et al., 2017), such analyses would have high value in further elucidating potential conditions that determine the pattern of theory effects. Similarly, intrapersonal characteristics, such as trait-level constructs (e.g., personality factors, trait self-control; Conner et al., 2023; Hagger et al., 2019) have been observed to moderate social cognition theory effects and, as data in the field proliferates,

syntheses in which differences in these intrapersonal factors serve to moderate protection motivation theory constructs may be possible.

Finally, the included studies did not adopt experimental or intervention designs involving manipulation of one or more constructs from protection motivation theory individually and testing the effects on other theory constructs or subsequent behavior. As a consequence, we treated all data for our current analysis as correlational data, which places restrictions on the extent to which we were able to make directional or causal inferences in the model effects and, as such, direction of our predictions and effect size estimates were based on theory alone. Further tests of protection motivation theory utilizing experimental and intervention designs, particularly factorial designs testing unique and interactive effects of multiple construct manipulations, are encouraged to better enable causal inferences within the theory and further clarify mechanisms of action.

Conclusion

Our current analysis provides an updated meta-analytic synthesis of the associations between protection motivation theory and health behavior, and is the first to test the unique theory-implied pattern of effects between the theory constructs and health behavior using meta-analytic structural equation modeling. Results provide overall and robust support for the unique key relations among protection motivation theory and health behavior and the mechanisms by which threat and coping appraisals relate to behavior, such as the hypothesized mediation effects by protection motivation. In addition, our results offer important information on candidate conceptual, methodological, and contextual conditions in which the theory is likely to operate more effectively through the inclusion of comprehensive moderator analyses. The current study further contributes to and corroborates the established evidence base of protection motivation theory as a useful framework for identifying determinants of health-related behavior, the relevant processes involved, and conditions that may influence its predictive power, which may serve as a basis for future experimental studies and research testing intervention strategies targeting theory constructs to promote health behavior change. Importantly, our analyses also highlight relatively underexplored areas of research in tests of protection motivation theory, such as the measurement of maladaptive coping strategies, utilization of conditional measures of perceived susceptibility, and the use of longitudinal study designs, and we urge researchers to further examine these topics to improve the quality and range of evidence for the predictive validity of the theory.

References

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, *50*(2), 179–211. https://doi.org/10.1016/0749-5978(91)90020-T

Alhemimah, A. (2023). How COVID-19 impacts travel-health information seeking and tourists' travel intentions: A protection motivation theory-based model. *Journal of Destination Marketing & Management*, *27*, 100757. https://doi.org/10.1016/j.jdmm.2022.100757

Bagozzi, R. P., Lee, K.-H., & Van Loo, M. F. (2001). Decisions to donate bone marrow: The role of attitudes and subjective norms across cultures. *Psychology & Health*, *16*(1), 29–56. https://doi.org/10.1080/08870440108405488

Balla, J., & Hagger, M. S. (2025). Protection motivation theory and health behaviour: Conceptual review, discussion of limitations, and recommendations for best practice and future research. *Health Psychology Review*, *19*(1), 145–171. https://doi.org/10.1080/17437199.2024.2413011

Bigsby, E., & Albarracín, D. (2022). Self- and response efficacy information in fear appeals: A meta-analysis. *Journal of Communication*, *72*(2), 241–263. https://doi.org/10.1093/joc/jqab048

Blanchard, C. M., Kupperman, J., Sparling, P., Nehl, E., Rhodes, R. E., Courneya, K. S., Baker, F., & Rupp, J. C. (2008). Ethnicity and the theory of planned behavior in an exercise context: A mediation and moderation perspective. *Psychology of Sport and Exercise*, *9*(4), 527–545. https://doi.org/10.1016/j.psychsport.2007.06.004

Boer, D., & Fischer, R. (2013). How and when do personal values guide our attitudes and sociality? Explaining cross-cultural variability in attitude–value linkages. *Psychological Bulletin*, *139*(5), 11. https://doi.org/10.1037/a0031347

Borenstein, M., Hedges, L. V., Higgins, J. P. T., & Rothstein, H. R. (2009). *Introduction to Meta-Analysis* (1st ed.). Wiley. https://doi.org/10.1002/9780470743386

Brewer, N. T., Chapman, G. B., Gibbons, F. X., Gerrard, M., McCaul, K. D., & Weinstein, N. D. (2007). Meta-analysis of the relationship between risk perception and health behavior: The example of vaccination. *Health Psychology*, *26*(2), 136–145. https://doi.org/10.1037/0278-6133.26.2.136

Brown, S. P., Westbrook, R. A., & Challagalla, G. (2005). Good cope, bad cope: Adaptive and maladaptive coping strategies following a critical negative work event. *Journal of Applied Psychology*, *90*(4), 792–798. https://doi.org/10.1037/0021-9010.90.4.792

Budreviciute, A., Damiati, S., Sabir, D. K., Onder, K., Schuller-Goetzburg, P., Plakys, G., Katileviciute, A., Khoja, S., & Kodzius, R. (2020). Management and prevention strategies for non-communicable diseases (NCDs) and their risk factors. *Frontiers in Public Health*, *8*, 574111. https://doi.org/10.3389/fpubh.2020.574111

Bui, L., Mullan, B., & McCaffery, K. (2013). Protection motivation theory and physical activity in the general Population: A systematic literature review. *Psychology, Health & Medicine*, *18*(5), 522–542. https://doi.org/10.1080/13548506.2012.749354

Carter, E. C., Schönbrodt, F. D., Gervais, W. M., & Hilgard, J. (2019). Correcting for bias in psychology: A comparison of meta-analytic methods. *Advances in Methods and*

Practices in Psychological Science, *2*(2), 115–144. https://doi.org/10.1177/2515245919847196

Centers for Disease Control and Prevention. (2021a). *Data and Statistics—Smoking and Tobacco Use*. https://www.cdc.gov/tobacco/data_statistics/index.htm

Centers for Disease Control and Prevention. (2021b). *FastStats—Exercise or Physical Activity*. https://www.cdc.gov/nchs/fastats/exercise.htm

Centers for Disease Control and Prevention. (2023). *Data on Excessive Drinking*. https://www.cdc.gov/alcohol/data-stats.htm#:~:text=According%20to%20the%20Behavioral%20Risk,drink%20heavily%20also%20binge%20drink.

Chen, Y.-L., Lin, Y.-J., Chang, Y.-P., Chou, W.-J., & Yen, C.-F. (2021). Differences in the protection motivation theory constructs between people with various latent classes of motivation for vaccination and preventive behaviors against COVID-19 in Taiwan. *International Journal of Environmental Research and Public Health*, *18*(13), 7042. https://doi.org/10.3390/ijerph18137042

Cheng, C., Cheung, M. W.-L., & Lo, B. C. Y. (2016). Relationship of health locus of control with specific health behaviours and global health appraisal: A meta-analysis and effects of moderators. *Health Psychology Review*, *10*(4), 460–477. https://doi.org/10.1080/17437199.2016.1219672

Cheung, M. W.-L. (2015). metaSEM: An R package for meta-analysis using structural equation modeling. *Frontiers in Psychology*, *5*. https://doi.org/10.3389/fpsyg.2014.01521

CIA. (2024). *Country comparisons-Real GDP (purchasing power parity)*. https://www.cia.gov/the-world-factbook/field/real-gdp-purchasing-power-parity/country-comparison/

Conner, M., McEachan, R., Jackson, C., McMillan, B., Woolridge, M., & Lawton, R. (2013). Moderating effect of socioeconomic status on the relationship between health cognitions and behaviors. *Annals of Behavioral Medicine*, *46*(1), 19–30. https://doi.org/10.1007/s12160-013-9481-y

Conner, M., & Norman, P. (2025). Attitudes, intentions and behavior change. *Annual Review of Psychology*.

Conner, M., Wilding, S., Wright, C. E., & Sheeran, P. (2023). How does self-control promote health behaviors? A multi-behavior test of five potential pathways. *Annals of Behavioral Medicine*, *57*(4), 313–322. https://doi.org/10.1093/abm/kaac053

Digby, P. G. N. (1983). Approximating the tetrachoric correlation coefficient. *Biometrics*, *39*(3), 753. https://doi.org/10.2307/2531104

Dixon, D., & Johnston, M. (2019). Content validity of measures of theoretical constructs in health psychology: Discriminant content validity is needed. *British Journal of Health Psychology*, *24*(3), 477–484. https://doi.org/10.1111/bjhp.12373

Fincher, C. L., & Thornhill, R. (2012). Parasite-stress promotes in-group assortative sociality: The cases of strong family ties and heightened religiosity. *Behavioral and Brain Sciences*, *35*(2), 61-79. https://doi.org/10.1017/S0140525X11000021

Fischer, R., Bailey, Y., Shankar, M., Safaeinili, N., Karl, J. A., Daly, A., Johnson, F. N., Winter, T., Arahanga-Doyle, H., Fox, R., Abubakar, A., & Zulman, D. M. (2024).

Cultural challenges for adapting behavioral intervention frameworks: A critical examination from a cultural psychology perspective. *Clinical Psychology Review*, *110*, 102425. https://doi.org/10.1016/j.cpr.2024.102425

Fischer, R., & Karl, J. A. (2022). Predicting behavioral intentions to prevent or mitigate COVID-19: A cross-cultural meta-analysis of attitudes, norms, and perceived behavioral control effects. *Social Psychological and Personality Science*, *13*(1), 264–276. https://doi.org/10.1177/19485506211019844

Fishbein, M., Cappella, J., Hornik, R., Sayeed, S., Yzer, M., & Ahern, R. K. (2001). The role of theory in developing effective antidrug public service announcements. In W. D. Crano, M. Burgoon, & S. Oskamp (Eds.), *Mass Media and Drug Prevention* (0 ed., pp. 89–118). Psychology Press. https://doi.org/10.4324/9781410603845-5

Floyd, D. L., Prentice-Dunn, S., & Rogers, R. W. (2000). A meta-analysis of research on protection motivation theory. *Journal of Applied Social Psychology*, *30*(2), 407–429. https://doi.org/10.1111/j.1559-1816.2000.tb02323.x

Gaston, A., & Prapavessis, H. (2014). Using a combined protection motivation theory and health action process approach intervention to promote exercise during pregnancy. *Journal of Behavioral Medicine*, *37*(2), 173–184. https://doi.org/10.1007/s10865-012-9477-2

Guo, X., Han, X., Zhang, X., Dang, Y., & Chen, C. (2015). Investigating m-Health acceptance from a protection motivation theory perspective: gender and age differences. *Telemedicine and E-Health*, *21*(8), 661–669. https://doi.org/10.1089/tmj.2014.0166

Gwet, K. L. (2008). Computing inter-rater reliability and its variance in the presence of high agreement. *British Journal of Mathematical and Statistical Psychology*, *61*(1), 29–48. https://doi.org/10.1348/000711006X126600

Hagger, M. S. (2025). Psychological Determinants of Health Behavior. *Annual Review of Psychology*, *76*(1), 821–850. https://doi.org/10.1146/annurev-psych-020124-114222

Hagger, M. S., Chatzisarantis, N. L. D., Barkoukis, V., Wang, J. C. K., Hein, V., Pihu, M., Soós, I., & Karsai, I. (2007). Cross-cultural generalizability of the theory of planned behavior among young people in a physical activity context. *Journal of Sport and Exercise Psychology*, *29*(1), 1–19. https://doi.org/10.1123/jsep.29.1.2

Hagger, M. S., & Hamilton, K. (2024). Longitudinal tests of the theory of planned behaviour: A meta-analysis. *European Review of Social Psychology*, *35*(1), 198–254. https://doi.org/10.1080/10463283.2023.2225897

Hagger, M. S., & Hamilton, K. (2025). Testing theory predictions and intervention mechanisms of action in sport and exercise psychology using meta-analysis. *Sport, Exercise, and Performance Psychology*, *14*(1), 96–119. https://doi.org/10.1037/spy0000352

Hagger, M. S., Hankonen, N., Kangro, E., Lintunen, T., Pagaduan, J., Polet, J., Ries, F., & Hamilton, K. (2019). Trait self-control, social cognition constructs, and intentions: correlational evidence for mediation and moderation effects in diverse health behaviours. *Applied Psychology: Health and Well-Being*, *11*(3), 407–437. https://doi.org/10.1111/aphw.12153

Hagger, M. S., Koch, S., Chatzisarantis, N. L. D., & Orbell, S. (2017). The common sense model of self-regulation: Meta-analysis and test of a process model. *Psychological Bulletin*, *143*(11), 1117–1154. https://doi.org/10.1037/bul0000118

Hagger, M. S., & Orbell, S. (2022). The common sense model of illness self-regulation: A conceptual review and proposed extended model. *Health Psychology Review*, *16*(3), 347–377. https://doi.org/10.1080/17437199.2021.1878050

Henrich, J., Heine, S. J., & Norenzayan, A. (2010). The weirdest people in the world? *Behavioral and Brain Sciences*, *33*(2–3), 61–83. https://doi.org/10.1017/S0140525X0999152X

Hodgkins, S., & Orbell, S. (1998). Can protection motivation theory predict behaviour? A longitudinal test exploring the role of previous behaviour. *Psychology & Health*, *13*(2), 237–250. https://doi.org/10.1080/08870449808406749

Hofstede, G. (2001). *Culture's consequences: Comparing values, behaviors, institutions, and organizations across nations* (2nd edition). Sage. https://linkinghub.elsevier.com/retrieve/pii/S0005796702001845

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal*, *6*(1), 1–55. https://doi.org/10.1080/10705519909540118

Kaufman, A. R., Twesten, J. E., Suls, J., McCaul, K. D., Ostroff, J. S., Ferrer, R. A., Brewer, N. T., Cameron, L. D., Halpern-Felsher, B., Hay, J. L., Park, E. R., Peters, E., Strong, D. R., Waters, E. A., Weinstein, N. D., Windschitl, P. D., & Klein, W. M. P. (2020). Measuring cigarette smoking risk perceptions. *Nicotine & Tobacco Research*, *22*(11), 1937–1945. https://doi.org/10.1093/ntr/ntz213

Kim, S. Y., Park, S. Y., Mathai, B., Daheim, J., France, C., & Delgado, B. (2022). Cultural dimensions of individualism and collectivism and risk of opioid misuse: A test of Social Cognitive Theory. *Journal of Clinical Psychology*, *78*(11), 2341–2356. https://doi.org/10.1002/jclp.23425

Lee, E. W. J., Ho, S. S., Chow, J. K., Wu, Y. Y., & Yang, Z. (2013). Communication and knowledge as motivators: Understanding Singaporean women's perceived risks of breast cancer and intentions to engage in preventive measures. *Journal of Risk Research*, *16*(7), 879–902. https://doi.org/10.1080/13669877.2012.761264

Leventhal, H., Phillips, L. A., & Burns, E. (2016). The common-sense model of self-regulation (CSM): A dynamic framework for understanding illness self-management. *Journal of Behavioral Medicine*, *39*(6), 935–946. https://doi.org/10.1007/s10865-016-9782-2

Li, J., Akaliyski, P., Heisig, J. P., Löbl, S., & Minkov, M. (2022). Flexible societies excelled in saving lives in the first phase of the COVID-19 pandemic. *Frontiers in Psychology*, *13*, 924385. https://doi.org/10.3389/fpsyg.2022.924385

Loef, M., & Walach, H. (2012). The combined effects of healthy lifestyle behaviors on all cause mortality: A systematic review and meta-analysis. *Preventive Medicine*, *55*(3), 163–170. https://doi.org/10.1016/j.ypmed.2012.06.017

Luszczynska, A., Scholz, U., & Schwarzer, R. (2005). The general self-efficacy scale: multicultural validation studies. *The Journal of Psychology*, *139*(5), 439–457. https://doi.org/10.3200/JRLP.139.5.439-457

Maddux, J. E., & Rogers, R. W. (1983). Protection motivation and self-efficacy: A revised theory of fear appeals and attitude change. *Journal of Experimental Social Psychology*, *19*(5), 469–479. https://doi.org/10.1016/0022-1031(83)90023-9

McAnally, K., & Hagger, M. S. (2023). Health literacy, social cognition constructs, and health behaviors and outcomes: A meta-analysis. *Health Psychology*, *42*(4), 213–234. https://doi.org/10.1037/hea0001266

McEachan, R. R. C., Conner, M., Taylor, N. J., & Lawton, R. J. (2011). Prospective prediction of health-related behaviours with the theory of planned behaviour: A meta-analysis. *Health Psychology Review*, *5*(2), 97–144. https://doi.org/10.1080/17437199.2010.521684

McEachan, R., Taylor, N., Harrison, R., Lawton, R., Gardner, P., & Conner, M. (2016). Meta-analysis of the reasoned action approach (RAA) to understanding health behaviors. *Annals of Behavioral Medicine*, *50*(4), 592–612. https://doi.org/10.1007/s12160-016-9798-4

McMillan, B., & Conner, M. (2007). Health cognition assessment. In S. Ayers, A. Baum, C. McManus, S. Newman, K. Wallston, J. Weinman, & R. West (Eds.), *Cambridge Handbook of Psychology, Health and Medicine* (2nd ed., pp. 260–266). Cambridge University Press. https://doi.org/10.1017/CBO9780511543579.057

Milne, S., Sheeran, P., & Orbell, S. (2000). Prediction and intervention in health-related behavior: a meta-analytic review of protection motivation theory. *Journal of Applied Social Psychology*, *30*(1), 106–143. https://doi.org/10.1111/j.1559-1816.2000.tb02308.x

Minkov, M. (2011). *Cultural differences in a globalizing world*. Ashgate.

Minkov, M., Bond, M. H., Dutt, P., Schachner, M., Morales, O., Sanchez, C., Jandosova, J., Khassenbekov, Y., & Mudd, B. (2018). A reconsideration of Hofstede's fifth dimension: New flexibility versus monumentalism data from 54 countries. *Cross-Cultural Research*, *52*(3), 309–333. https://doi.org/10.1177/1069397117727488

Morren, M., & Grinstein, A. (2021). The cross-cultural challenges of integrating personal norms into the Theory of Planned Behavior: A meta-analytic structural equation modeling (MASEM) approach. *Journal of Environmental Psychology*, *75*, 101593. https://doi.org/10.1016/j.jenvp.2021.101593

Murray, D. R., & Schaller, M. (2010). Historical prevalence of infectious diseases within 230 geopolitical regions: A tool for investigating origins of culture. *Journal of Cross-Cultural Psychology*, *41*(1), 99–108. https://doi.org/10.1177/0022022109349510

Nezami, B. T., Lang, W., Jakicic, J. M., Davis, K. K., Polzien, K., Rickman, A. D., Hatley, K. E., & Tate, D. F. (2016). The effect of self-efficacy on behavior and weight in a behavioral weight-loss intervention. *Health Psychology*, *35*(7), 714–722. https://doi.org/10.1037/hea0000378

Norman, P., Boer, H., Seydel, E. R., & Mullan, B. (2015). Protection motivation theory. In M. Conner & P. Norman (Eds.), *Predicting and changing health behavior: Research and practice with social cognition models* (Third Edition, pp. 70–106). Open University Press.

O'Connor, S. M., Jardine, A. G., & Millar, K. (2008). The prediction of self-care behaviors in end-stage renal disease patients using Leventhal's Self-Regulatory Model. *Journal of Psychosomatic Research*, *65*(2), 191–200. https://doi.org/10.1016/j.jpsychores.2008.02.008

Orbell, S., Zahid, H., & Henderson, C. J. (2020). Changing behavior using the health belief model and protection motivation theory. In M. S. Hagger, L. Cameron, K. Hamilton, N. Hankonen, & T. Lintunen (Eds.), *The handbook of behavior change* (pp. 46–59). Cambridge University Press.

Peters, G.-J. Y., Ruiter, R. A. C., & Kok, G. (2013). Threatening communication: A critical re-analysis and a revised meta-analytic test of fear appeal theory. *Health Psychology Review*, *7*(sup1), S8–S31. https://doi.org/10.1080/17437199.2012.703527

Petrova, D., Okan, Y., Salamanca-Fernández, E., Domínguez-López, S., Sánchez, M.-J., & Rodríguez-Barranco, M. (2020). Psychological factors related to time to help-seeking for cancer symptoms: A meta-analysis across cancer sites. *Health Psychology Review*, *14*(2), 245–268. https://doi.org/10.1080/17437199.2019.1641425

Plotnikoff, R. C., & Trinh, L. (2010). Protection motivation theory: is this a worthwhile theory for physical activity promotion? *Exercise and Sport Sciences Reviews*, *38*(2), 91–98. https://doi.org/10.1097/JES.0b013e3181d49612

Protogerou, C., & Hagger, M. S. (2020). A checklist to assess the quality of survey studies in psychology. *Methods in Psychology*, *3*, 100031. https://doi.org/10.1016/j.metip.2020.100031

Rad, M. S., Martingano, A. J., & Ginges, J. (2018). Toward a psychology of Homo Sapiens: Making psychological science more representative of the human population. *Proceedings of the National Academy of Sciences*, *115*(45), 11401–11405. https://doi.org/10.1073/pnas.1721165115

Rich, A., Brandes, K., Mullan, B., & Hagger, M. S. (2015). Theory of planned behavior and adherence in chronic illness: A meta-analysis. *Journal of Behavioral Medicine*, *38*(4), 673–688. https://doi.org/10.1007/s10865-015-9644-3

Rogers, R. W. (1975). A protection motivation theory of fear appeals and attitude change. *The Journal of Psychology: Interdisciplinary and Applied*, *91*(1), 93–114. APA PsycInfo®. https://doi.org/10.1080/00223980.1975.9915803

Rosenstock, I. M. (1966). Why people use health services. *The Milbank Memorial Fund Quarterly*, *44*(3), 94. https://doi.org/10.2307/3348967

Rudman, L. A., Hope Gonzales, M., & Borgida, E. (1999). mishandling the gift of life: noncompliance in renal transplant patients. *Journal of Applied Social Psychology*, *29*(4), 834–851. https://doi.org/10.1111/j.1559-1816.1999.tb02028.x

Schenker, N., & Gentleman, J. F. (2001). On judging the significance of differences by examining the overlap between confidence intervals. *The American Statistician*, *55*(3), 182–186. https://doi.org/10.1198/000313001317097960

Schüz, B. (2017). Socio-economic status and theories of health behaviour: Time to upgrade a control variable. *British Journal of Health Psychology*, *22*(1), 1–7. https://doi.org/10.1111/bjhp.12205

Schüz, B., Li, A. S.-W., Hardinge, A., McEachan, R. R. C., & Conner, M. (2017). Socioeconomic status as a moderator between social cognitions and physical activity: Systematic review and meta-analysis based on the Theory of Planned Behavior. *Psychology of Sport and Exercise*, *30*, 186–195. https://doi.org/10.1016/j.psychsport.2017.03.004

Self, C. A., & Rogers, R. W. (1990). Coping with threats to health: Effects of persuasive appeals on depressed, normal, and antisocial personalities. *Journal of Behavioral Medicine*, *13*(4), 343–357. https://doi.org/10.1007/BF00844883

Sheeran, P., Maki, A., Montanaro, E., Avishai-Yitshak, A., Bryan, A., Klein, W. M. P., Miles, E., & Rothman, A. J. (2016). The impact of changing attitudes, norms, and self-efficacy on health-related intentions and behavior: A meta-analysis. *Health Psychology*, *35*(11), 1178–1188. https://doi.org/10.1037/hea0000387

Steinmetz, H., Knappstein, M., Ajzen, I., Schmidt, P., & Kabst, R. (2016). How effective are behavior change interventions based on the theory of planned behavior?: A three-level meta-analysis. *Zeitschrift Für Psychologie*, *224*(3), 216–233. https://doi.org/10.1027/2151-2604/a000255

Triandis, H. C. (2018). *Individualism and Collectivism* (1st ed.). Routledge. https://doi.org/10.4324/9780429499845

Umeh, K. (2004). Cognitive appraisals, maladaptive coping, and past behaviour in protection motivation. *Psychology & Health*, *19*(6), 719–735. https://doi.org/10.1080/08870440420001966692

United Nations Development Programme [UNDP]. (2024). *Human Development Report 2023-24: Breaking the gridlock: Reimagining cooperation in a polarized world*. New York. https://hdr.undp.org/system/files/documents/global-report-document/hdr2023-24reporten.pdf

Uz, I. (2015). The index of cultural tightness and looseness among 68 countries. *Journal of Cross-Cultural Psychology*, *46*(3), 319–335. https://doi.org/10.1177/0022022114563611

Van Der Velde, F. W., & Van Der Pligt, J. (1991). AIDS-related health behavior: Coping, protection motivation, and previous behavior. *Journal of Behavioral Medicine*, *14*(5), 429–451. https://doi.org/10.1007/BF00845103

Viechtbauer, W. (2010). Conducting Meta-Analyses in *R* with the **metafor** Package. *Journal of Statistical Software*, *36*(3). https://doi.org/10.18637/jss.v036.i03

Wicker, A. W. (1969). Attitudes versus actions: The relationship of verbal and overt behavioral responses to attitude objects. *Journal of Social Issues*, *25*(4), 41–78. https://doi.org/10.1111/j.1540-4560.1969.tb00619.x

Williams, L. J., & Holahan, P. J. (1994). Parsimony-based fit indices for multiple-indicator models: Do they work? *Structural Equation Modeling: A Multidisciplinary Journal*, *1*(2), 161–189. https://doi.org/10.1080/10705519409539970

Wilson, S. J., Polanin, J. R., & Lipsey, M. W. (2016). Fitting meta-analytic structural equation models with complex datasets. *Research Synthesis Methods*, *7*(2), 121–139. https://doi.org/10.1002/jrsm.1199

Zhang, C.-Q., Zhang, R., Schwarzer, R., & Hagger, M. S. (2019). A meta-analysis of the health action process approach. *Health Psychology*, *38*(7), 623–637. https://doi.org/10.1037/hea0000728

Appendices

Figure 1. Diagrammatic representation of the proposed full model indicating hypothesized relations between protection motivation theory variables and behavior (panel a) and the proposed truncated model with threat and coping appraisal variables collapsed into their corresponding latent constructs (panel b).

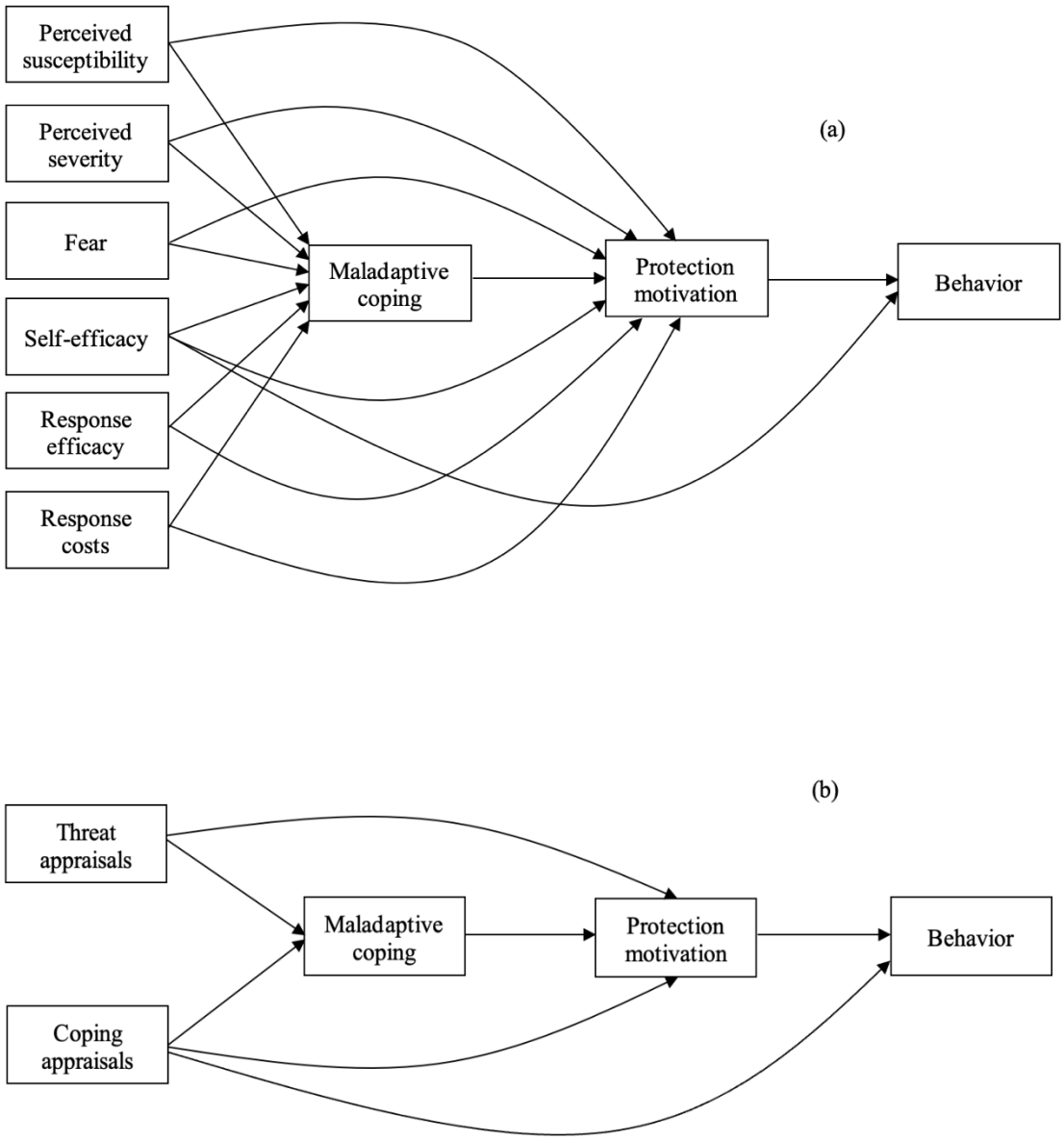


Table 1

Standardized Parameter Estimates and 95% Confidence Intervals for Multilevel Meta-Analytic Structural Equation Model of the Full Version of Protection Motivation Theory in the Overall Sample of Studies – Unadjusted and Adjusted for Covariates

Effect	Unadjusted model			Covariate-adjusted model		
	β	95% CI		β	95% CI	
		LL	UL		LL	UL
Direct effects						
Severity→PM	.046*	.010	.081	.049*	.011	.087
Susceptibility→PM	.080***	.045	.115	.086***	.049	.123
Fear→PM	.110***	.059	.160	.117***	.063	.170
Response costs→PM	.122***	.078	.165	.130***	.083	.176
Response efficacy→PM	.189***	.160	.217	.197***	.168	.227
Self-efficacy→PM	.234***	.205	.262	.238***	.207	.268
Severity→MC	.050	-.026	.126	.064	-.016	.145
Susceptibility→MC	.050	-.030	.130	.062	-.023	.148
Fear→MC	-.063	-.167	.041	-.058	-.169	.053
Response costs→MC	.288***	.214	.362	.315***	.238	.391
Response efficacy→MC	-.065	-.141	.011	-.058	-.138	.022
Self-efficacy→MC	.117**	.045	.188	.134***	.059	.210
MC→PM	.027	-.036	.090	.035	-.031	.101
PM→Behavior	.334***	.304	.364	.366***	.336	.397
Self-efficacy→Behavior	.174***	.145	.203	.191***	.161	.222
Indirect effects						
Susceptibility→PM→Behavior	.026***	.015	.039	.031***	.018	.045
Severity→PM→Behavior	.015*	.003	.027	.018*	.004	.032
Fear→PM→Behavior	.037***	.019	.054	.043***	.023	.062
Self-efficacy→PM→Behavior	.078***	.066	.090	.087***	.074	.101
Response efficacy→PM→Behavior	.063***	.052	.074	.072***	.060	.085
Response costs→PM→Behavior	.040***	.025	.056	.047***	.030	.065

Susceptibility→MC→PM→Behavior	.000	-.001	.001	.000	-.001	.003
Severity→MC→PM→Behavior	.000	-.001	.001	.000	-.001	.003
Fear→MC→PM→Behavior	-.001	-.002	.001	-.001	-.003	.001
Self-efficacy→MC→PM→Behavior	.001	-.001	.004	.002	-.002	.005
Response efficacy→MC→PM→Behavior	-.001	-.002	.001	-.001	-.003	.001
Response costs→MC→PM→Behavior	.003	-.003	.009	.004	-.004	.012
Sums of indirect effects						
Threat appraisals→PM→Behavior[a]	.042***	.026	.058	.049***	.031	.068
Coping appraisals→PM→Behavior[b]	.104***	.084	.123	.120***	.098	.142
Threat appraisals→MC→PM→Behavior[c]	.001	-.001	.003	.002	-.002	.005
Coping appraisals→MC→PM→Behavior[d]	.002	-.003	.007	.003	-.003	.010
Total effects						
Appraisal constructs→Behavior[e]	.438***	.406	.469	.496***	.466	.527
Correlations						
Susceptibility↔Severity	.264***	.229	.298	.303***	.269	.337
Susceptibility↔Fear	.377***	.335	.419	.418***	.376	.460
Severity↔Fear	.302***	.249	.355	.341***	.288	.394
Susceptibility↔Self-efficacy	.102***	.071	.132	.143***	.113	.174
Severity↔Self-efficacy	.146***	.116	.177	.187***	.156	.218
Fear↔Self-efficacy	.122***	.074	.170	.164***	.116	.212
Susceptibility↔Response efficacy	.173***	.141	.205	.213***	.180	.245
Severity↔Response efficacy	.187***	.153	.221	.226***	.193	.260
Fear↔Response efficacy	.155***	.102	.208	.195***	.142	.248
Self-efficacy↔Response efficacy	.310***	.280	.333	.345***	.319	.372
Susceptibility↔Response costs	.118***	.079	.158	.159***	.119	.199
Severity↔Response costs	.058**	.014	.102	.099***	.054	.143
Fear↔Response costs	.106***	.045	.167	.146***	.086	.207
Self-efficacy↔Response costs	.239***	.200	.278	.281***	.242	.321
Response efficacy↔Response costs	.099***	.062	.136	.139***	.102	.176

Note. Model parameters are adjusted for the following covariates: age, sex, sample type (student vs. non-student), sample type (clinical vs. non-clinical), study design, and study quality. None of the parameter estimates were statistically significantly

different across unadjusted and covariate-adjusted versions of the model based on Schenker and Gentleman's (Schenker, N., & Gentleman, J. F. (2001). On judging the significance of differences by examining the overlap between confidence intervals. *The American Statistician, 55*(3), 182-186. https://doi.org/10.1198/000313001317097960) 'standard method' based on confidence intervals. [a]Sum of indirect effects of threat appraisal constructs (susceptibility, severity, and fear) on behavior through protection motivation. [b]Sum of indirect effects of coping appraisal constructs (response costs, response efficacy, and self-efficacy) on behavior through protection motivation. [c]Sum of indirect effects of threat appraisal constructs (susceptibility, severity, and fear) on behavior through maladaptive coping and protection motivation. [d]Sum of indirect effects of coping appraisal constructs (response costs, response efficacy, and self-efficacy) on behavior through maladaptive coping and protection motivation. [e]Total effect of all appraisal constructs on behavior through maladaptive coping and protection motivation plus direct effects. β = Standardized path coefficient; 95% CI = 95% confidence interval of parameter estimate; LL = Lower limit of 95% CI; PM= Protection motivation; MC = Maladaptive coping; Behavior = Health behavior.
***$p < .001$ **$p < .01$ *$p < .05$

Table 2

Standardized Parameter Estimates and 95% Confidence Intervals for Multilevel Meta-Analytic Structural Equation Model of the Truncated Version of Protection Motivation Theory in the Overall Sample of Studies – Unadjusted and Adjusted for Covariates

Effect	Unadjusted model			Covariate-adjusted model		
	β	95% CI		β	95% CI	
		LL	UL		LL	UL
Direct effects						
Threat appraisals→Protection motivation	.163***	.144	.182	.172***	.153	.190
Coping appraisals→Protection motivation	.281***	.261	.300	.287***	.267	.307
Threat appraisals→Maladaptive coping	.036	-.005	.077	.046*	.005	.086
Coping appraisals→Maladaptive coping	.161***	.122	.200	.173***	.133	.212
Maladaptive coping→Protection motivation	.067***	.013	.121	.075**	.021	.129
Protection motivation→Behavior	.347***	.319	.376	.360***	.331	.389
Coping appraisals→Behavior	.122***	.101	.143	.126***	.105	.147
Indirect effects						
Threat appraisals→PM→Behavior	.056***	.048	.065	.062***	.053	.071
Coping appraisals→PM→Behavior	.098***	.086	.109	.103***	.092	.115
Threat appraisals→MC→PM→Behavior	.001	-.000	.002	.001	-.000	.003
Coping appraisals→MC→PM→Behavior	.004*	.001	.007	.005***	.001	.008
Sums of indirect effects						
Threat appraisals→PM/MC→Behavior[a]	.058***	.049	.066	.063***	.054	.072
Coping appraisals→PM/MC→Behavior[b]	.101***	.090	.113	.108***	.096	.120
Total effects						
Coping appraisals→Behavior[c]	.223***	.203	.243	.234***	.214	.254
Correlations						
Threat appraisals↔Coping appraisals	.137***	.118	.156	.150***	.131	.169

Note. Model parameters are adjusted for the following covariates: age, sex, sample type (student vs. non-student), sample type (clinical vs. non-clinical), study design, and study quality. None of the parameter estimates were statistically significantly

different across unadjusted and covariate-adjusted versions of the model based on Schenker and Gentleman's (Schenker, N., & Gentleman, J. F. (2001). On judging the significance of differences by examining the overlap between confidence intervals. *The American Statistician, 55*(3), 182-186. https://doi.org/10.1198/000313001317097960) 'standard method' based on confidence intervals. [a]Sum of indirect effects of threat appraisals on behavior through protection motivation and maladaptive coping. [b]Sum of indirect effects of coping appraisals on behavior through protection motivation and maladaptive coping. [c]Total effect of coping appraisals on behavior through maladaptive coping and protection motivation including direct effect of coping appraisals on behavior. β = Standardized path coefficient; 95% CI = 95% confidence interval of parameter estimate; LL = Lower limit of 95% CI I; PM= Protection motivation; MC = Maladaptive coping; Behavior = Health behavior.
***$p < .001$ **$p < .01$ *$p < .05$