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The Health Belief Model as an Explanatory Framework in Communication Research: Exploring Parallel, Serial, and Moderated Mediation

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The Health Belief Model (HBM) posits that messages will achieve optimal behavior change if they successfully target perceived barriers, benefits, self-efficacy, and threat. While the model seems to be an ideal explanatory framework for communication research, theoretical limitations have limited its use in the field. Notably, variable ordering is currently undefined in the HBM. Thus, it is unclear whether constructs mediate relationships comparably (parallel mediation), in sequence (serial mediation), or in tandem with a moderator (moderated mediation). To investigate variable ordering, adults ($N = 1{,}377$) completed a survey in the aftermath of an 8-month flu vaccine campaign grounded in the HBM. Exposure to the campaign was positively related to vaccination behavior. Statistical evaluation supported a model where the indirect effect of exposure on behavior through perceived barriers and threat was moderated by self-efficacy (moderated mediation). Perceived barriers and benefits also formed a serial mediation chain. The results indicate that variable ordering in the Health Belief Model may be complex, may help to explain conflicting results of the past, and may be a good focus for future research.

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As one of the most widely applied theories of health behavior (Glanz & Bishop, 2010), the Health Belief Model (HBM) posits that six constructs predict health behavior: risk susceptibility, risk severity, benefits to action, barriers to action, self-efficacy, and cues to action (Becker, 1974; Champion & Skinner, 2008; Rosenstock, 1974). Originally formulated to model the adoption of preventive health behaviors in the United States, the HBM has been successfully adapted to fit diverse cultural and topical contexts (e.g., Griffin, 2012; Scarinci et al., 2012).

Widely used in other fields, the HBM would seem to be ideal for communication research. Surprisingly, the HBM is utilized less frequently by communication scholars. Communication researchers are primarily interested in explicating communication processes, an objective that favors explanatory frameworks (Slater & Gleason, 2012). As an explanatory framework, the HBM has significant limitations. Notably, researchers have argued that the HBM fails to specify variable ordering (Champion & Skinner, 2008). This limitation is significant for researchers interested in utilizing the HBM to understand communication processes, as numerous process-oriented questions are raised by the model that currently have no answer. For example, it is possible that all six variables serve as equivalent mediators (parallel mediation; see Champion et al., 2008), that some variables form sequential or serial chains (serial mediation; see Janz & Becker, 1984), or that variables are hierarchically situated so that some moderate the mediational influence of others (moderated mediation; see Champion & Skinner, 2008). Unfortunately, these different models are rarely examined or compared in the literature (Champion & Skinner, 2008).

The current study seeks to advance the HBM as an explanatory framework for communication research (Slater & Gleason, 2012) by examining three possible models (parallel, serial, moderated mediation) in the evaluation of an H1N1 vaccination campaign. A single campaign evaluation cannot validate a particular model, but it can compare the veracity of each model within a particular context and provide a template for process-oriented HBM research. The latter is needed, as researchers have not pursued this question despite frequent calls for process-oriented research (e.g., Champion & Skinner, 2008; Strecher, Champion, & Rosenstock, 1997). The results of this research will be especially useful to scholars interested in testing the direct and indirect effects of messages grounded in the HBM.

INDIANA'S H1N1 VACCINE CAMPAIGN

The swine flu outbreak of 2009 was the first pandemic in more than 40 years, and for many, their first encounter with a major influenza outbreak. In response, the Indiana State Department of Health (ISDH), funded by the federal government, launched an aggressive H1N1 vaccination campaign. The 30-second television and radio spots featured Indiana Governor Mitch Daniels and state health commissioner Judy Monroe, who encouraged Indiana citizens through messages such as, "Don't get the flu, don't spread the flu."

Considering the overwhelming amount of news media coverage regarding the H1N1 flu outbreak, campaign developers aimed to build upon existing perceptions of one's risk by situating campaign messages within the central components of the HBM (Becker, 1974; Rosenstock, 1974). Using radio and television, the ISDH crafted a series of public service announcements, in both English and Spanish, aimed at increasing awareness of the flu as well as encouraging vaccination through emphasis on the benefits of vaccination, overcoming vaccination barriers, and increasing people's perceptions of their own ability to get vaccinated. In an effort to increase evaluation of communication campaigns, the Centers for Disease Control and Prevention (CDCP) provided additional funding for a post hoc, third-party evaluation of the campaign.

To gauge the impact of the campaign, the evaluation team tracked H1N1 vaccination behavior and encoded exposure. Mass media scholars have noted in various contexts that mere physical proximity to electronic media (or time spent with it) does not guarantee any meaningful engagement with information presented (Southwell et al., 2002). Emergent research has shifted its focus to consider whether presentation of content in the mass media generates at least a minimal memory trace in individuals, called "encoded exposure" (Southwell et al., 2002, p. 446). Measuring encoded exposure entails a precise and efficient mechanism for identifying whether individuals have encountered a message, in that it assesses the more basic ability to respond to a closed-ended question about past engagement with specific content when presented with that content once again, requiring a relatively high degree of current information saliency and accessibility. Additionally, encoded campaign exposure appears to be a function of one's own past behavioral engagement, as perceived personal relevance often motivates effortful processing, largely through its facilitation of storage in one's memory (Southwell, 2005). Thus, it was hypothesized that encoded exposure to the campaign would be positively related to H1N1 vaccination (H1).

THE HEALTH BELIEF MODEL

In addition to a direct relationship between encoded exposure and H1N1 vaccination, it is plausible that indirect effects occurred through HBM variables targeted by the campaign. The HBM posits that people will take action to prevent illness if they regard themselves as susceptible to a condition (perceived susceptibility), if they believe it would have potentially serious consequences (perceived severity), if they believe that a particular course of action available to them would reduce the susceptibility or severity or lead to other positive outcomes (perceived benefits), and if they perceive few negative attributes related to the health action (perceived barriers). Additionally, HBM scholars later suggested that self-efficacy—the belief that one can successfully complete the behavior of interest despite considered barriers—be added to the model (Rosenstock, Strecher, & Becker, 1988). However, in actuality, self-efficacy is rarely included in HBM studies (Carpenter, 2010). Although less investigated, the model also suggests that specific cues, such as factors in one's environment, can impact the final action one takes (Champion & Skinner, 2008). These cues to action can be internal or external, ranging from experiencing symptoms of an illness to exposure to a campaign (Bish & Michie, 2010). Much like self-efficacy, cues to action have not been systematically evaluated, particularly considering their often fleeting nature (Champion & Skinner, 2008).

Four meta-analyses have been conducted to assess the viability of the HBM and its constructs in predicting behavior, but their findings have been inconsistent. The first analysis (focusing on counting statistically significant relationships rather than synthesizing effect sizes) was conducted between 1974 and 1984 (Becker, 1974; Janz & Becker, 1984) and established substantial empirical support for the model, with findings from prospective studies at least as favorable as those obtained from retrospective research. Perceived barriers were the most powerful single predictor of preventive health behavior across all studies and behaviors, and perceived severity was the least powerful predictor. Both perceived susceptibility and perceived benefits were important predictors of protective health behavior; however, perceived susceptibility was a stronger predictor of preventive health behavior.

Conversely, the meta-analysis of Harrison and colleagues (1992) found that the impact of each HBM variable on behavior was fairly small. However, this analysis has been critiqued for not correcting effect size estimates in light of the unequal split in behavioral outcome measures as well as the unreliability of HBM variable measures (Carpenter, 2010). In terms of the model's overall impact, an analysis by Zimmerman and Vernberg (1994) focused on the predictive power of the model in its entirety, finding that the HBM was able to predict future behavior, but only weakly in comparison to other health behavior theories. More recently, in a meta-analysis of 18 studies ($N = 2{,}702$), including those of the 1994 analysis as well as 12 HBM studies published since then, Carpenter (2010) found that benefits and barriers were consistently the strongest predictors. Overall, within the analysis, the estimates were low for the relationship between subjects' estimate of how severe a given negative health outcome would be and their likelihood of adopting the target behavior. Additionally, the relationship between susceptibility beliefs and behavior was near zero.

These meta-analyses reveal conflict within the HBM literature. For instance, HBM variables appear to be differentially related to behavior, a finding suggestive of an underlying (and undefined) hierarchy for the constructs in the model. Not only does this hinder research progress, but it also could explain inconsistency in the reviews. Unfortunately, in most individual studies, variable ordering is not tested, as HBM variables tend to be analyzed in light of their additive impact on an outcome variable. For instance, Nexoe, Kragstrup, and Sogaard (1999) found that the HBM components of perceived severity, perceived barriers, and perceived benefits were mutually significant predictors of influenza vaccination acceptance. Likewise, Champion and colleagues have found that severity, susceptibility, benefits, barriers, and self-efficacy predicted mammography adherence (Champion, 1984; Champion, Ray, Heilman, & Springston, 2000; Champion & Menon, 1997; Champion, Skinner, & Menon, 2005; Champion et al., 2008). This pattern can also be seen in research on the Extended Health Belief Model (EHBM). Bylund and colleagues (2011) utilized the EHBM, which includes the traditional four HBM variables in addition to cues to action and self-efficacy, to predict sibling perceptions of their risk for hereditary hemochromatosis. In line with research norms, all six variables were analyzed for their additive impact on risk perceptions.

Thus, despite a large body of research supporting the influence of HBM variables on health behavior, ambiguity still exists concerning which variables are most important and how variables interact within the model. Strecher, Champion, and Rosenstock (1997) lamented the frequency with which the HBM was implemented as a four-variable model with only additive effects on behavior. They suggested future HBM research should begin evaluating more complex causal models. Champion and Skinner (2008) issued a similar call in their recent review of the HBM:

> Although the HBM identifies constructs that lead to outcome behaviors, relationships between and among these constructs are not defined. This ambiguity has led to variation in HBM applications. For example, whereas many studies have attempted to establish each of the major dimensions as independent, others have tried multiplicative approaches. Analytical approaches to identifying these relationships are needed to further the utility of the HBM in predicting behavior. (p. 50)

Exploring variable ordering within the HBM will advance theory and practice by improving evaluation, identifying relative importance of the constructs, and suggesting new postulates for behavior change.

VARIABLE ORDERING IN THE HEALTH BELIEF MODEL

As a starting point, there are three basic models that seem relevant to the HBM. First, the variables could have comparable influence on outcomes. Most visual depictions of the HBM suggest this ordering, as all of the constructs are presented in a vertical line with arrows pointing toward behavior or behavioral intention (e.g., see the "health belief model" box in Champion & Skinner, 2008, p. 49). This is a plausible model as HBM constructs are conceptualized in the literature as channels of influence (Champion & Skinner, 2008). Messages are thought to influence behaviors through one or more of these channels. From a process standpoint, this model is best described as parallel mediation. In parallel mediation, all of the HBM constructs are hypothesized to be influenced by the independent variable (e.g., campaign exposure) and to influence the dependent variable (e.g., vaccination behavior). This model assumes that the HBM constructs do not influence one another (Hayes, 2012). Cues to action are often included as parallel predictors in such models, but communication researchers are more likely to conceptualize external cues as the predictor variable (e.g., campaign exposure).

The second possibility is that the HBM constructs could function as a causal chain, a model referred to as serial mediation (Hayes, 2012). For example, campaign exposure could increase self-efficacy, self-efficacy could influence perceived barriers, and perceived barriers could predict behavior (campaign exposure → self-efficacy → perceived barriers → behavior). This is plausible, as an efficacy-centered message could lead to increased perceptions of self-efficacy, and these increased perceptions of self-efficacy may in turn lead one to recognize the benefits of engaging in the behavior, only identifiable after developing a sense of efficacy. Though a complete causal chain is unlikely, it is plausible that some of the variables of the HBM connect in this way (e.g., barriers and benefits). Serial mediation is important to explore, as the differential impact of specific HBM constructs could be symptomatic of an underlying (and untested) causal chain.

Third, and finally, a moderated mediation model would assume that one of the HBM constructs serves as a moderator for the influence of the others (Hayes, 2012). For example, Champion and Skinner (2008) argued that both perceived threat and perceived severity may moderate the impact of other HBM variables. Particularly, they contended that increased severity is required before susceptibility is able to significantly predict behavior. The authors also suggested that perceived benefits and perceived barriers may be able to better predict behavior when the perception of threat is greater. They note, "Under conditions of low perceived threat, benefits of and barriers to engaging in health-related behaviors should not be salient. This relationship, however, may be altered in situations where benefits are perceived to be very high and barriers very low" (Champion & Skinner, 2008, p. 61).

The present study engages the issue of variable ordering in the HBM by exploring three models—parallel, serial, or moderated mediation—using data from a flu vaccination campaign grounded in the HBM. In addition to testing direct effects, the project explored parallel, serial, and moderated mediation models (RQ1).

METHODS

Campaign Design and Evaluation

To increase use of the H1N1 flu vaccine, the Indiana State Department of Health (ISDH) designed and carried out an 8-month-long media campaign (October 2009–May 2010) grounded in the HBM. The campaign was designed and implemented by the ISDH; however, a third-party, post hoc evaluation was requested by the Centers for Disease Control and Prevention to better understand the impact of the campaign.

To that end, a research team carried out the evaluation once the media campaign was concluded (May 2010–June 2010). The sites were selected in accordance with the media plan set forward by the ISDH at the beginning of the campaign. Specifically, the media campaign was implemented in the nine largest media markets across the state of Indiana. To ensure that the assessment clearly considered individuals in a variety of the ISDH-selected media markets, and to maximize the representativeness of the sample, the seven sites surveyed in this evaluation were randomly selected from a larger pool of collection sites within these nine major areas. While Indianapolis received the largest amount of marketing investment, the ISDH asked that the evaluation efforts of this particular study refrain from assessing individuals in this central area, as they had sufficient data about the capitol city. Excluding Indianapolis is also logical as it is not similar to the other cities in the study (e.g., larger population, more urban).

Four graduate students, one undergraduate, and a faculty member from a Midwestern University carried out the evaluation. At each site, data collection was conducted at a centralized location selected by site coordinators where a large number of the population could view recruitment materials. Participation was completely voluntary. Large recruitment posters were presented at each site noting the estimated time necessary for completion of the survey, the university responsible for the assessment, and the compensation awardable to those who participated. Participants were seated at a table and given as much time as necessary to complete the evaluation and view the PSAs. After completion of the evaluation, or if a participant indicated that he or she wished not to continue mid-completion, the individual was compensated with a $10 gift card.

Sample

To evaluate the H1N1 flu vaccine media campaign, adults across the state of Indiana ($N = 1{,}377$) completed a survey assessing attitudes, beliefs, and behaviors related to vaccination. Participant age ranged from 18 to 90 years ($M = 34.70$, $SD = 15.21$). More than half the participants were female (61.1%). In terms of race/ethnicity, 80.8% of the sample were White, 9.5% were Black, 4.6% were Asian/Pacific Islander, 4.0% were Hispanic, 1.3% were Native American, and 0.1% self-described as other (participants could check more than one racial/ethnic category). Roughly a fifth of the participants did not have health insurance (21.0%) and 6.8% reported having only Medicare/Medicaid. Almost two-thirds (61.8%) had at least one child in the house. The number of children in a household ranged from 0 to 15 ($M = 1.41$, $SD = 1.58$). The sample is similar to that of the Indiana population: 50.8% female, 86.8% White, 9.4% Black, 1.8% Asian/Pacific Islander, 0.4% Native American, and 6.2% Hispanic (U.S. Census Bureau, 2012).

Outcome Measure

The survey was conducted May 2010–June 2010 following an 8-month media campaign (October 2009–May 2010) designed to increase utilization of the H1N1 flu vaccine. To assess the impact of the campaign, participants were asked whether they had received the H1N1 flu vaccine (*No* = 0, *Yes* = 1). Most participants had not received the vaccine (77%) and a few did not answer the question (1.5%). The remainder reported receiving the vaccine (21.5%).

Indiana, the state where the evaluation was conducted, estimated that 23.3% (95% confidence interval: 21.4%, 25.2%) of adults 18 years and older received the H1N1 flu vaccine during 2009–2010 (Centers for Disease Control and Prevention, 2011). This places Indiana just ahead of the national average for H1N1 flu vaccination during that period (22.7%; 95% confidence interval: 22.9%, 23.1%).

Moderators/Mediators

HBM variables were assessed using modified versions of scales validated by Champion and colleagues (Champion, 1999; Champion & Skinner, 2003; Champion, Skinner, & Menon, 2005). All questions had response options ranging from *strongly disagree* to *strongly agree*.

Perceived threat. Previous research has found that perceived susceptibility is a better predictor than severity (Janz & Becker, 1984), although findings are somewhat conflicted on this issue (Carpenter, 2010). Champion (1999) noted that perceived severity often has insufficient variance (for breast cancer risk); a problem that led her to initially drop it from the model. More recently, Champion and Skinner (2008) have argued that perceived susceptibility and severity may combine to form a single construct, which they refer to as perceived threat. In the present study, participant beliefs about their susceptibility to/the severity of the H1N1 flu were assessed using a 4-item scale modeled after Champion's (1999) revised susceptibility scale. The scale includes items such as "It is likely that I will get the H1N1 flu" and "I believe that H1N1 flu is severe" ($M = 3.15$, $SD = .92$, $\alpha = .80$).

Perceived self-efficacy. Participant self-efficacy was assessed using a modified version of the mammography self-efficacy scale (Champion, Skinner, & Menon, 2005). The H1N1 flu vaccination self-efficacy scale included nine items, such as "You can arrange transportation to get the H1N1 flu vaccine" ($M = 4.09$, $SD = .87$, $\alpha = .94$).

Perceived benefits. Perceived benefits were assessed using a four-item scale modeled after Champion's (1999) perceived benefits scale. The scale included items such as "Getting the H1N1 vaccine will decrease my chances of dying from the H1N1 flu" ($M = 3.40$, $SD = .92$, $\alpha = .89$).

Perceived barriers. Perceived barriers were assessed using a 10-item scale modeled after Champion's (1999) perceived barriers scale. The scale includes items such as "Getting the H1N1 flu vaccine exposes me to unnecessary health risks" ($M = 1.80$, $SD = .65$, $\alpha = .85$)

Controls

Five variables were controlled for in this study: education, gender, age, flu shot history, and H1N1 flu history. Cameron and colleagues (2009) found that beliefs regarding one's susceptibility to flu varied based on perceptions of individual health status, background knowledge, and age-related risk. Thus, education, gender, and age were added as covariates. Research also shows that flu shot history, particularly one's seasonal vaccination history, is highly correlated with H1N1 vaccination intentions (Maurer et al., 2009). Accordingly, both flu shot history and H1N1 flu history were added as covariates.

Predictor

After completing the survey, participants were shown two ISDH televised public service announcements (PSAs) and two radio PSAs via hand-held PALM TXs. After viewing/listening to each PSA, participants indicated whether they had encountered a PSA previously (*No* = 0, *Yes* = 1). In terms of exposure, 64.6% had encountered at least one of the PSAs: one (26.7%), two (23.7%), three (8.9%), or four (5.3%). Thus, the predictor was positively skewed ($M = 1.27$, $SD = 1.26$). Of note, PSA recognition did vary by location for one TV PSA. The research team collected data at seven locations throughout the state of Indiana. Four locations had a major city (population 100,000+) and three did not. We recoded the location data so that the three rural locations were combined and the four urban locations were combined (rural = 0, urban = 1). For TV spot 1, participants from rural locations were less likely to have seen the spot (45.8%) compared to those from urban locations (53.8%), χ^2 (1) = 8.39, $p = .004$. Including location in the analyses does not alter the evaluation results, so this difference was omitted from the analyses.

RESULTS

All hypotheses were tested using logistic regression or a conditional process modeling program, PROCESS, that utilizes an ordinary least-squares- or logistic-based path analytical framework to test for both direct and indirect effects (Hayes, 2012). PROCESS is ideal for analyzing the current data because it allows researchers to explore parallel, moderated, and serial mediation models. Specifically, the current analysis employed PROCESS Models 4 (parallel mediation), 6 (serial mediation), and 8 (moderated mediation). All indirect effects were subjected to follow-up bootstrap analyses with 1000 bootstrap samples and 95% bias-corrected confidence intervals.

It was hypothesized (H1) that encoded exposure would be positively related to behavior (i.e., the c path). H1 was tested by regressing behavior on exposure and the covariates (education, gender, age, flu shot history, and H1N1 flu history). The total effects model was significantly better than the null model, Cox & Snell $R^2 = .25$, –2 log likelihood = 941.39, $\chi^2 = 341.92$, $df = 6$, $p < .001$ (see Total Effects Model in Table 1). Consistent with H1, exposure was a significant predictor of behavior. In other words, controlling for the covariates, a 1-unit increase in encoded exposure increased the odds of vaccination by 40%. Those who had seen/heard two PSAs were 80% more likely to have been vaccinated than those who had seen/heard zero. Younger, more educated participants and those with a personal history of receiving flu shots or contracting the H1N1 flu were more likely to have been vaccinated. Gender was not significantly related to behavior.

TABLE 1
Logistic Regression Predicting Vaccination Behavior—Total and Direct Effects Models

	B (SE)	*Z*	*Odds Ratio*	*Odds Ratio, 95% CI*
Total Effects Model				
Age	−.02 (.01)**	−2.98	.98	.97, .99
Gender	.10 (.17)	.55	1.11	.79, 1.55
Education	.19 (.05)*	3.49	1.21	1.09, 1.34
Flu shot history	.90 (.07)***	12.77	2.45	2.13, 2.81
H1N1 history	2.08 (.24)***	8.61	7.98	4.97, 12.80
Exposure	.17 (.06)**	2.67	1.18	1.04, 1.34
Direct Effects Model				
Age	−.02 (.01)***	−3.66	.98	.96, .99
Gender	−.20 (.19)	−1.02	.82	.56, 1.20
Education	.09 (.06)	1.54	1.10	.98, 1.23
Flu shot history	.80 (.08)***	10.50	2.22	1.91, 2.58
H1N1 history	2.12 (.27)***	7.94	8.30	4.92, 13.98
Barriers	−.99 (.17)***	−5.73	.37	.27, .52
Benefits	.68 (.12)***	5.66	1.98	1.56, 2.50
Threat	.29 (.12)*	2.46	1.33	1.06, 1.68
Efficacy	.14 (.13)	1.14	1.16	.90, 1.48
Exposure	.14 (.07)†	1.87	1.15	.99, 1.32

Note. Logistic regression predicting H1N1 flu vaccination. The Total Effects Model depicts the predictive power of exposure with covariates included. The Direct Effects Model depicts the predictive power of exposure with covariates and mediators included. Tests of indirect mediation effects are included in text. $N = 1198$.

†$p < .10$; *$p < .05$; **$p < .01$; ***$p < .001$.

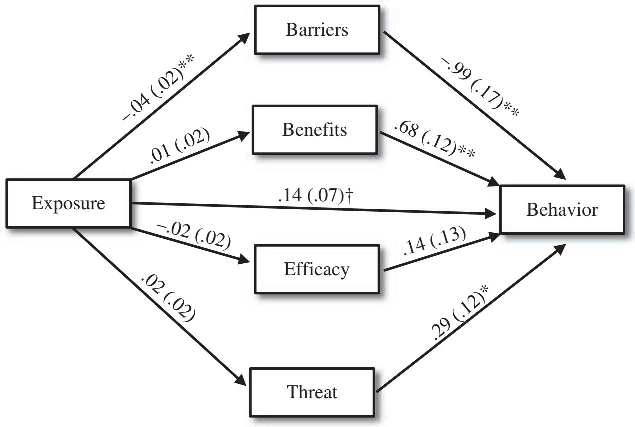
Thus, as hypothesized, exposure to the campaign had a positive effect on vaccination behavior. Yet, from a theory standpoint, the more interesting question is whether there are significant indirect effects. The campaign was designed using the HBM, which postulates that four constructs are key targets for public health practitioners seeking to change behavior: barriers, benefits, efficacy, and threat. In other words, the relationship between exposure and behavior should be (primarily) moderated and/or mediated by those four constructs.

Parallel Mediation

Parallel mediation assumes that all four HBM constructs mediate the relationship between exposure and behavior in a comparable manner. To test this model, behavior was entered as the outcome variable, exposure as the predictor variable, education, gender, age, flu shot history, and H1N1 flu history as covariates, and all fourth constructs as mediators. The parallel mediation model was significantly better than the exposure model, Cox & Snell $R^2 = .33$, –2 log likelihood = 798.02, $\chi^2 = 480.55$, $df = 10$, $p < .001$. Exposure was still related to behavior after mediators were taken into account although the relationship was weaker and only marginally significant (see Direct Effects Model in Table 1). The direct effect was reduced as exposure indirectly influenced behavior via perceived barriers, $b = .0374$, $SE = .0165$, 95% CI: .0059, .0724. Participants with greater exposure perceived fewer barriers, a perception that was related to increased vaccination (see Figure 1). No mediation was found for perceived benefits, $b = .0045$, $SE = .0159$, 95% CI: –.0280, .0364, efficacy, $b = –.0024$, $SE = .0046$, 95% CI: –.0174, .0027, or threat, $b = .0057$, $SE = .0074$, 95% CI: –.0064, .0245.

Serial Mediation

Serial mediation assumes "a causal chain linking the mediators, with a specified direction of causal flow" (Hayes, 2012, p. 14). For example, exposure could decrease perceived barriers, which could increase perceived benefits and thus increase behavior (i.e., exposure → barriers → benefits → behavior). To test for serial mediation, behavior was entered as the outcome variable, exposure as the predictor variable, education, gender, age, flu shot history, and H1N1 flu history as covariates, and all four HBM constructs as serial mediators.



Parallel mediation, $N = 1198$

FIGURE 1 Parallel mediation model. Significant differences: †$p < .10$, *$p < .05$, **$p < .01$.

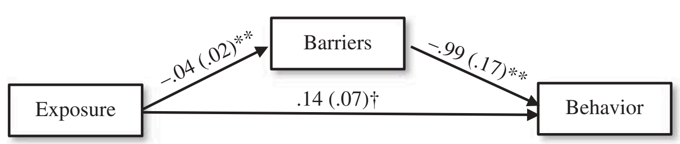
For serial mediation, PROCESS tests all possible variable combinations for a particular variable ordering (specified by the analyst). Thus, if a data analyst enters the variables in the following order (barriers, benefits, self-efficacy, threat), then PROCESS would test this model—exposure > barriers > benefits > behavior—but it would not test this one—exposure > benefits > barriers > behavior. To get the latter, a data analyst would have to enter the variables so benefits came before barriers (e.g., benefits, barriers, self-efficacy, threat).

With four variables, there are 24 possible ordering permutations. To test all permutations, a data analyst would need to run 24 separate serial mediation analyses. Accordingly, we ran 24 serial mediation analyses, but reporting the results of all 24 didn't seem optimal for two reasons: (a) It would be daunting from a space standpoint and (b) two variables functioned as serial mediators (barriers and benefits) and only when the former was entered before the latter (i.e., barriers, benefits). Given that, we report a single variable ordering (barriers, benefits, self-efficacy, threat).

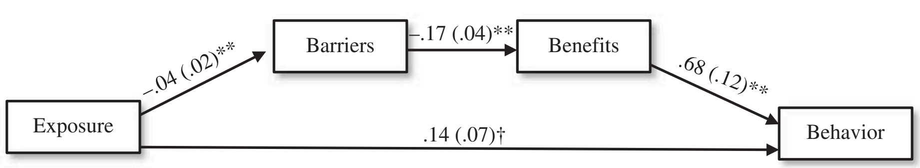
For that ordering, PROCESS evaluated 15 serial models and only two were significant (Model 1 and Model 2). Of the two models, Model 1 is superior as it explains more variance; however, Model 2 has interesting findings that are worth noting from a theoretical perspective. Model 1 tested whether perceived barriers mediated the relationship between exposure and behavior; that indirect effect was significant, $b = .0374$, $SE = .0162$, 95% bootstrap confidence interval: .0103, .0768 (see Model 1 in Figure 2). Participants with greater exposure perceived fewer barriers and thus were more likely to have been vaccinated. In essence, Model 1 is a simple mediation model (i.e., one mediator variable). Model 2 tested the following causal chain: exposure → barriers → benefits → behavior. That indirect effect was significant, $b = .0044$, $SE = .0023$, 95% bootstrap confidence interval: .0013, .0107. An examination of the coefficients revealed that exposure was negatively related to perceived barriers, barriers was negatively related to benefits, and benefits was positively related to behavior (see Model 2 in Figure 2). In other words, those with greater campaign exposure perceived fewer barriers, those who perceived fewer barriers perceived more benefits to vaccination, and greater perceived benefits were positively related to vaccination behavior.

Moderated Mediation

Moderated mediation can take many forms (e.g., Preacher, Rucker, & Hayes, 2007). The current analysis tests whether the indirect effect of exposure on behavior through an HBM variable (e.g., barriers) is moderated by one of the other HBM variables (e.g., efficacy). To test for moderated mediation, four logistic regression analyses were conducted using PROCESS. Variables were entered identical to parallel mediation, except that one of the HBM variables was selected as a

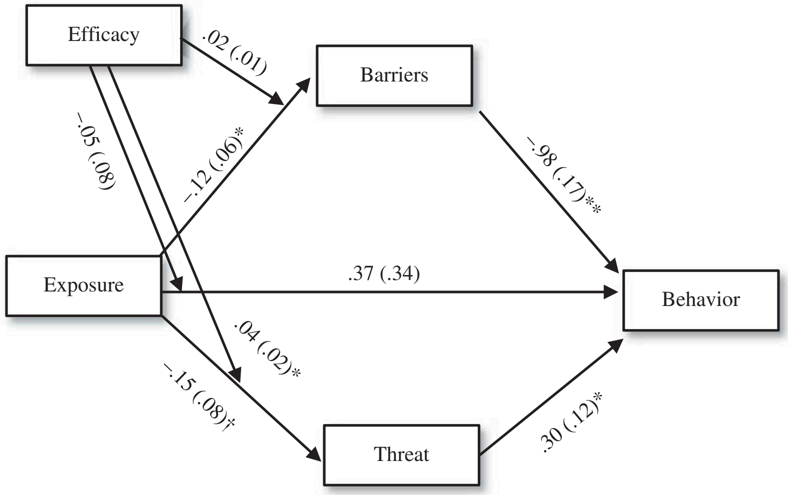


Serial Mediation – Model 1. $N = 1198$.



Serial mediation—Model 2. $N = 1198$.

FIGURE 2 Significant serial mediation models. Significant differences: †$p < .10$, *$p < .05$, **$p < .01$.



Moderated mediation—efficacy. $N = 1198$.

FIGURE 3 Moderated mediation model with self-efficacy as a moderator. Significant differences: †$p < .10$, *$p < .05$, **$p < .01$.

moderator. Significant moderation was probed at three points (the mean and ±1 standard deviation).

Only one moderation model (efficacy) yielded significant moderated mediation. With efficacy entered as the moderator, the model was significant, Cox & Snell $R^2 = .33$, –2 log likelihood $= 797.52$, $\chi^2 = 481.05$, $df = 10$, $p < .001$. Efficacy significantly moderated the meditational effect of barriers and threat (see Figure 3). Exposure was related to decreased perceived barriers and increased threat, perceptions which were related to behavior. However, moderated mediation analysis revealed that perceived barriers was only a significant mediator for individuals with low to moderate efficacy (see Table 2). Perceived barriers did not matter for those with very high efficacy. Threat was only a significant mediator for individuals with high efficacy.

TABLE 2
Conditional Indirect Effects of Exposure on Behavior at Values of the Moderator

	Moderator Efficacy	*b (SE)*	*95% CI*
Perceived barriers			
−1 SD	−.8594	.0542 (.0277)*	(.0030, .1130)
Mean	.0000	.0383 (.0160)*	(.0097, .0758)
+1 SD	.8594	.0224 (.0196)	(−.0167, .0653)
Perceived threat			
−1 SD	−.8594	−.0029 (.0095)	(−.0267, .0129)
Mean	.0000	.0084 (.0076)	(−.0024, .0278)
+1 SD	.8594	.0197 (.0131)*	(.0027, .0579)

Note. Four moderated mediation analyses were conducted with a different HBM construct specified as the moderator each time (i.e., efficacy, threat, barriers, or benefits). Only the model with efficacy as a moderator yielded significant moderated mediation. Significant conditional indirect effects are reported in this table with 1000 bootstrap samples and 95% confidence intervals. Bootstrapping reveals, for example, that perceived barriers reliably mediates the relationship between exposure and behavior for those with moderate efficacy, as the 95% confidence interval for the coefficient does not overlap zero.

*$p < .05$.

DISCUSSION

Parallel, serial, and all four moderated mediation analyses yielded interesting results. Parallel mediation analysis revealed that perceived barriers mediated the exposure > behavior relationship, serial mediation analysis found a significant chain between barriers and benefits, and moderated mediation analysis suggested that self-efficacy could moderate the mediational effects of barriers and threat. A definitive model cannot be derived from the data in hand—because the data are not longitudinal and they focus on the effects of a single campaign—but it does suggest that researchers should consider alternative variable ordering in HBM research. For example, the notion that perceived barriers and benefits form a causal chain is consistent with early HBM research suggesting the two variables should be transformed into a difference score (Janz & Becker, 1984). Moreover, the presence of so many complex variable relationships suggests that conflicts in past research may be rectified by increased understanding of variable ordering in the HBM.

Previous research has identified perceived barriers as a significant predictor of behavior (Carpenter, 2010; Janz & Becker, 1984). The present study is consistent with this idea, as perceived barriers consistently mediated the relationship between exposure and behavior across all models. The implication is that researchers and practitioners should focus their efforts on identifying and countering perceived barriers. Yet these data also suggest that perceived barriers are meaningfully engaged only for individuals with low to moderate self-efficacy. This suggests that self-efficacy could be low because individuals perceived insurmountable barriers to action. Perhaps targeting the latter will eventually increase the former. Where self-efficacy is high, public health practitioners may find it beneficial to target perceived threat. Threat is more effective for high-self-efficacy populations, a finding that is consistent with the Extended Parallel Process Model (Witte, 1992, 2013). Perceived benefits, on the other hand, may be a lower priority or best targeted at a later stage in a multistage campaign. For example, once self-efficacy and threat are high and (presumably) perceived barriers are low, then the influence of perceived benefits could manifest to influence behavior. Thus, an 8-month campaign (as carried out here) might devote the first 4 months to targeting perceived barriers and the second 4 months to perceived benefits and threat.

Additionally, in the context of the ISDH flu vaccination campaign, the primary message focus was that of overcoming barriers to vaccination, with little interest in providing direct efficacy-centered messages. Campaign crafters also assumed that the public was already aware of the pandemic—and the need to prevent its spread—and thus messages targeted perceived severity and susceptibility as only subsidiary interests (a strategy examined by recent threat research, see Carcioppolo et al., 2013). Indiana vaccine demand exceeded supply during the duration of the campaign, which may have led to altered perceptions regarding one's ability to complete the recommended behavior. This may be why exposure to the campaign failed to alter self-efficacy solely and instead changed perceptions of perceived barriers or barriers in conjunction with self-efficacy.

Cues to action remain an underdeveloped construct within the larger HBM framework. The current study examined the influence of an external cue to action, namely, encoded exposure to a flu vaccine campaign. Absent from the analysis was a measure of internal cues to action (e.g., perceived symptoms of H1N1) and a more comprehensive account of all external cues (e.g., news stories about H1N1). Continued explication of the construct should examine whether it is beneficial to separate external and internal cues to action as well as manipulated cues (e.g., campaigns, interventions) and naturally occurring cues (e.g., news stories, sudden illness in the family).

A second construct explication and measurement issue concerns perceived threat. Perceived susceptibility and severity were combined into a single construct, perceived threat, per the recommendations of Champion and Skinner (2008). The four-item perceived threat scale was internally reliable and functioned as a significant mediator variable. The concern is that susceptibility and severity may be distinct constructs that need to be modeled independently. Separating the four-item scale into two two-item scales (representing susceptibility and severity) does not alter the basic pattern of results in the current study. Yet past research (though somewhat conflicted) has produced results that suggest susceptibility and severity are unique constructs (Carpenter, 2010; Janz & Becker, 1984). Research focused specifically on these constructs would improve model testing for a number of theories, including the HBM.

The current study is limited in several ways. First, the study was not designed to identify the optimal model for all HBM enterprises. The data in hand allow researchers to examine how variables interacted for one topic and one campaign. These results could be atypical, a possibility that researchers should consider as they evaluate the HBM across other topics/campaigns. Validating an optimal model and/or models for the HBM will require numerous replications across a variety of contexts (Holbert & Stephenson, 2002). Second, the evaluation was a post hoc and cross-sectional test of the statistical validity of different models based upon theory and previous research findings, and thus causality cannot be properly evaluated. A longitudinal design would offer stronger evidence of campaign effects and a more rigorous platform for evaluating models. For example, serial mediation analysis assumes that the ordering of the mediator variables (selected by the analyst) conforms to the order in which they were measured. Thus, a more rigorous test of serial mediation would measure all four mediators at multiple points in time so that, for instance, Time 2 benefits could be examined as a mediator of Time 1 barriers. Such a design would allow researchers to rigorously test parallel, serial, and moderated mediation models (for more details on longitudinal designs, see Singer & Willett, 2003). It is commonplace for researchers to note the limitations of cross-sectional data. In this case, it is essential that readers understand that the current analysis is only exploratory, and meant to serve as a possible guide for the actual tests of variable ordering that will occur in the years to come. Third, the study is based on a convenience sample and is therefore best suited to addressing process-oriented questions (e.g., variable ordering). It is not a good sample for establishing population characteristics (e.g., vaccination rate). Fourth, there is the potential that vaccination status may have led to selective exposure or memory bias, thus suggesting reverse causality. It is important for future researchers to take into account the role of personal relevance and prior behavioral engagement, as both often motivate more effortful processing of messages. Fifth, PROCESS does not model latent variables, so the current analyses rely on observed variables (Hayes, 2012). However, replication of the same analyses in a program that does allow latent-variable structural equation modeling (SEM) analysis (Mplus) yielded results that mirror those reported here.

The HBM is one of the most widely utilized and heavily studied theories in public health. Decades of research have helped to refine the model, yet variable ordering remains a relatively understudied topic. The present study explored three plausible models—parallel, serial, and moderate mediation—and identified a complex underlying hierarchy with a moderator (self-efficacy), one mediator (barriers), and a causal chain (barriers → benefits). The results suggest a potential hierarchy for targeting HBM constructs and provide a platform for future model testing in this area.

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REFERENCES

Becker, M. H. (1974). The Health Belief Model and personal health behavior. *Health Education Monographs*, *2*, 324–508.

Bish, A., & Michie, S. (2010). Demographic and attitudinal determinants of protective behaviors during a pandemic: A review. *British Journal of Health Psychology*, *15*(4), 797–824. doi:10.1348/135910710X485826

Briss, P. A., Rodewald, L. E., Hinman, A. R., Sheffer, A. M., Strikas, R. A., Bernier, R. R., . . . Williams, S. (2000). Review of evidence regarding interventions to improve vaccination coverage in children, adolescents, and adults. *American Journal of Preventive Medicine*, *18*(1s), 97–140. doi:10.1016/S0749-3797(99)00118-X

Bylund, C., Guegen, J., D'Agostino, T., Imes, R., & Sonet, E. (2011). Cancer patients decisions about discussing internet information with their doctors. *Psycho-Oncology*, *18*, 1189–1146. doi:10.1002/pon.1511

Carcioppolo, N., Jensen, J. D., Wilson, S. E., Collins, W. B., Carrion, M., & Linnemeier, G. (2013). Examining HPV threat-to-efficacy ratios in the Extended Parallel Process Model. *Health Communication, 28,* 20–28.

Cameron, K. A., Rintamaki, L. S., Kamanda-Kosseh, M., Noskin, G. A., Baker, D. W., & Makoul, G. (2009). Using theoretical constructs to identify key issues for targeted message design: African American seniors' perceptions about influenza and influenza vaccination. *Health Communication*, *24*, 316–326. doi:10.1080/10410230902889258

Carpenter, C. J. (2010). A meta-analysis of the effectiveness of the health belief model variables in predicting behavior. *Health Communication*, *25*, 661–669. doi:10.1080/10410236.2010.521906

U.S. Census Bureau. (2012). *Indiana Quickfacts*. Retrieved from http://quickfacts.census.gov/qfd/states/18000.html

Centers for Disease Control and Prevention. (2011). *Final estimates for 2009–10 Seasonal Influenza and Influenza A (H1N1) 2009 Monovalent Vaccination Coverage—United States, August 2009 through May, 2010*. Retrieved from http://www.cdc.gov/flu/professionals/vaccination/coverage_0910estimates.htm

Champion, V. L. (1984). Instrument development for Health Belief Model constructs. *ANS: Advances in Nursing Science*, *6*, 73–85.

Champion, V. L. (2009). Revised susceptibility, benefits, and barriers scale for mammography screening. *Research in Nursing and Health*, *22*(4), 341–348. doi:10.1002/(SICI)1098-240X(199908)22:4

Champion, V. L., & Menon, U. (1997). Predicting mammography and breast self examination in African American women. *Cancer Nursing*, *20*, 315–322. doi:10.1097/00002820-199710000-00002

Champion, V. L., Monahan, P. O., Springston, J. K., Russell, K., Zollinger, T., Saywell, R., & Maraj, M. (2008). Measuring mammography and breast cancer beliefs in African American women. *Journal of Health Psychology*, *13*, 827–837.

Champion, V. L., Ray, D. W., Heilman, D. K., & Springston J. K. (2000). A tailored intervention for mammography among low-income African-American women. *Journal of Psychosocial Oncology*, *18*(4), 1–13. doi:10.1300/J077v18n04_01

Champion, V., & Skinner, C. S (2005). Differences in perceptions of risk, benefits, and barriers by stages of mammography change. *Journal of Women's Health*, *12*, 277–286. doi:10.1089/154099903321667618.

Champion, V., Skinner, C. S., & Menon, U. (2005). Development of a Self-Efficacy Scale for mammography. *Research in Nursing and Health*, *28*, 329–336. doi:10.1002/nur.20088

Champion, V., & Skinner, C. S. (2008). The Health Belief Model. In K. Glanz, B. Rimer, & K. Viswanath (Eds.), *Health behavior and health education* (4th ed., pp. 45–65). San Francisco, CA: Jossey-Bass.

Cummings, K. M., Jette, A. M., Brock, B. M., & Haefner, D. P. (1979). Psychosocial determinants of immunization behavior in a swine influenza campaign. *Medical Care*, *17*, 639–649. doi:10.1097/00005650-197906000-00008

Farrelly, M. C., Davis, K. C., Duke, J., & Messeri, P. (2007). Sustaining 'truth': Changes in youth tobacco attitudes and smoking intentions after 3 years of a national antismoking campaign. *Health Education Research*, *24*(1), 42–48. doi:10.1093/her/cym087

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention, and behavior: An introduction to theory and research*. Reading, MA: Addison-Wesley.

Glanz, K., & Bishop, D. B. (2012). The role of behavioral science theory in the development and implementation of public health interventions. *Annual Review of Public Health*, *21*, 299–418. doi:10.1146/annurev.publhealth.012809.103604

Griffin, M. J. (2012). Health belief model, social support, and intention to screen for colorectal cancer in older African American men. *Health Promotion & Education*, *51*(1), 12–22.

Harrison, J. A., Mullen, P. D., & Green, L. (1992). A meta-analysis of the health belief model with adults. *Health Education Research*, *7*(1), 107–116. doi:10.1093/her/7.1.107

Hayes, J. A. (2012). *PROCESS: A versatile computational tool for observed variable mediation, moderation, and conditional process modeling* [White paper]. Retrieved from http://www.afhayes.com/public/process2012.pdf

Hilton, S., & Smith, E. (2010). Public views of the UK media and government reaction to the 2009 swine flu pandemic. *BMC Public Health*, *10*, 697–707. doi:10.1186/1471-2458-10-697

Holbert, R. L., & Stephenson, M. T. (2002). Structural equation modeling in the communication sciences, 1995-2000. *Human Communication Research*, *28*, 531–551. doi:10.1111/j.1468-2958.2002.tb00822.x

Janz, N. K., & Becker, M. H. (1984). The health belief model: A decade later. *Health Education & Behavior*, *11*(1), 1–47. doi:10.1177/109019818401100101

Maurer, J., Harris, K., Parker, A., & Lurie, N. (2009). Does receipt of seasonal influenza vaccine predict intention to receive novel H1N1 vaccine: Evidence from a nationally representative sample of US adults. *Vaccine*, *27*(42), 5732–5734. doi:10.1016/j.vaccine.2009.07.080

Preacher, K. J., Rucker, D. D., & Hayes, A. F. (2007). Assessing moderated mediation hypotheses: Theory, methods, and prescription. *Multivariate Behavioral Research*, *42*, 185–227. doi:10.1080/00273170701341316

Preacher, K. J., & Hayes, A. F. (2008). Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behavior Research Methods*, *40*, 879–891. doi:10.3758/BRM.40.3.879

Rosenstock, I. M. (1974). Historical origins of the health belief model. *Health Education Monographs*, *2*, 328–335. doi:10.1177/109019817400200403

Rosenstock, I. M., Strecher, V., & Becker, J. (1988). Social learning theory and the health belief model. *Health Education Quarterly*, *15*, 175–183. doi:10.1177/109019818801500203

Scarinci, I., Bandura, L., Hidalgo, B., & Cherrington, A. (2012). Development of a theory based, culturally relevant intervention on cervical cancer prevention among Latina immigrants using intervention mapping. *Health Promotion Practice*, *13*, 29–40. doi:10.1177/1524839910366416

Singer, J. D., & Willett, J. B. (2003). *Applied longitudinal data analysis: Modeling change and event occurrence*. New York, NY: Oxford University Press.

Slater, M. D., & Gleason, L. S. (2012). Contributing to theory and knowledge in quantitative communication science. *Communication Methods and Measures*, *6*, 215–236. doi:10.1080/19312458.2012.732626

Southwell, B., Barmada, C., Hornik, R., & Maklan, D. (2002). Can we measure encoded exposure? Validation evidence from a national campaign. *Journal of Health Communication*, *7*, 445–453. doi:10.1080/10810730290001800

Southwell, B. (2005). Between messages and people: A multilevel model for memory of television content. *Communication Research*, *32*, 112–140. doi:10.1177/0093650204271401

Stretcher, V. J., Champion, V. L., & Rosenstock, I. M. (1997). The health belief model and health behavior. In D. S. Goschman (Ed.), *Handbook of health behavior research* (Vol. 1, pp. 71–91). New York, NY: Plenum.

Witte, K. (1992). Putting the fear back into fear appeals: The extended parallel process model. *Communication Monographs*, *59*, 329–349.

Witte, K. (2013). Introduction: Pathways. *Health Communication*, *28*, 3–4.

Zimmerman, R. S., & Vernberg, D. (1994). Models of preventative health behavior: Comparison, critique, and meta-analysis. In G. Albrecht (Ed.), *Advances in medical sociology, Health behavior models: A reformulation* (pp. 45–67). Greenwich, CT: JAI Press.

Zimmerman, R. K., Nowalk, M. P., Raymund, M., Tabbarah, M., Hall, D. G., Wahrenberger, T., . . . Ricci, E. M. (2003). Tailored interventions to increase influenza vaccination in neighborhood health centers serving the disadvantaged. *American Journal of Public Health*, *93*, 1699–1705. doi:10.2105/AJPH.93.10.1699