Testing a Hierarchy-of-Effects Model

Pathways from Awareness to Outcomes in the VERB™ Campaign 2002–2003

Adrian Bauman, PhD, FAFPHM, Heather R. Bowles, PhD, Marian Huhman, PhD, Carrie D. Heitzler, MPH, Neville Owen, PhD, Ben J. Smith, PhD, Bill Reger-Nash, EdD

Background: The McGuire hierarchy-of-effects (HOE) model, used extensively in mass-media interventions to describe the mechanisms for understanding effects, has not been tested in physical activity campaigns.

Design: Data collected at baseline (2002) and follow-up (2003) surveys in the VERB™ evaluation were used in structural equation modeling to test pathways and hierarchies of campaign effects.

Setting/participants: Population-based cohort of youth aged 9–13 years (N=2364) for whom complete baseline and follow-up data were available.

Main outcome measures: Awareness of the VERB campaign, understanding of the VERB message, attitude toward being active, outcome expectations, and physical activity participation.

Results: Among youth aged 9–13 years (tweens) in the study cohort, significant paths were identified between awareness and understanding (0.72, $p<0.001$) and between understanding and being physically active (0.11, $p<0.05$). At baseline there was a high prevalence of positive attitudes and outcome expectations, and these were not influenced by change in understanding or awareness. Among inactive tweens only, the same paths were identified except that, in this subgroup, attitude was related to physical activity (0.13, $p<0.05$), and awareness was more strongly related to physical activity than it was for the whole sample (0.14, $p<0.01$).

Conclusions: These findings provided limited support for the HOE model and suggest that increased awareness and understanding were the key proximal effects that led to behavior change. A distinct sequence of effects, which bypassed attitudes and outcome expectations, was found for these U.S. young people. The findings could inform the design of future campaigns to address youth physical activity.

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Introduction

The VERB™ Campaign in a Public Health Context

Improving public health requires approaches that reach a large proportion of the population at a relatively low cost and that are likely to influence community understanding, beliefs, and (hopefully) behaviors. Mass-media communications campaigns with social marketing are increasingly used as initial stages in a public health approach to promote community awareness and indicate the need for behavior change.[1,2] Using the mass media and social marketing for persuasive communications is not new[3]; it has been used for decades to inform the public about preventing infectious disease, controlling tobacco use, and reducing drunk driving.

In recent years, large-scale mass-media campaigns have been developed in several countries to promote physical activity and prevent obesity.[4,5] These campaigns were usually carried out by government agencies or nonprofit organizations, and they targeted inactive or insufficiently active adults with messages promoting the idea of achievable levels of participation in moderate-intensity physical activities.[4] The most recent campaigns promoted incidental physical activity and active living, consistent with the

From the Centre for Physical Activity and Health, School of Public Health, University of Sydney (Bauman, Bowles, Smith), New South Wales, Australia; National Center for Chronic Disease Prevention and Health Promotion, CDC (Huhman), Atlanta, Georgia; University of Minnesota (Heitzler), Minneapolis, Minnesota; School of Population Health, University of Queensland (Owen), Brisbane, Queensland, Australia; and the School of Community Medicine, West Virginia University School of Medicine (Nash), Morgantown, West Virginia

Address correspondence and reprint requests: Adrian Bauman, PhD, FAFPHM, Centre for Physical Activity and Health, School of Public Health, Building K25, Level 2 Medical Foundation Building, University of Sydney, Sydney 2006 NSW, Australia. E-mail: adrianb@health.usyd.edu.au.

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evidence summarized in the U.S. Surgeon General's Report.[6] Most were short term, involved paid media messages and community events, and targeted adults at the population level.[7–12] The few campaigns aimed at youth included messages to encourage physical activity, but their emphasis was nutrition and they used mainly PSAs, websites, and brochures (e.g., Bone Health Campaign and Eat Smart. Play Hard).

Thus, before the VERB campaign, no well-resourced mass-media campaign targeted "tweens" whose level of physical activity was decreasing: time spent watching television was increasing, walking or bicycling to school was decreasing, and obesity was increasing.[13–16] The VERB campaign, developed by the CDC and launched in 2002, was a media-led multi-strategy initiative based on some of the principles of social marketing,[3,17] targeting U.S. tweens (girls and boys aged 9–13 years). The mass-media component was particularly important in the first year of the campaign; local programs and events became important in later years.

To penetrate the busy U.S. media market, VERB was allocated a large advertising budget for the first year (around $50 million). After 1 year, evaluation data showed that a large proportion of the target audience were aware of the VERB campaign and could recall its main messages. In addition, tween's sessions of physical activity increased, especially among those who reported maximal exposure to the campaign.[18]

Assessing How the VERB Campaign Worked: Testing the Hierarchy-of-Effects Model

Evaluations of most media campaigns focus on the short- to medium-term effects on a range of variables but so far have not explored the mechanisms through which media campaigns might exert their influence. To examine these mechanisms, researchers need to use theories of media effects explicitly, and empirically test them. A good understanding of how campaigns work can help shape the direction and content of subsequent campaigns and, in the long term, can guide strategies for media reinforcement of initial campaign effects and the design of supportive programs. This is an important part of theory-testing, and its role in public health efforts to increase healthy lifestyles and physical activity.[19]

The VERB campaign developed a logic model that demonstrated how its objectives related to campaign inputs and events.[20] This model posited that campaign awareness would result in changes to intermediate variables, such as subjective norms and attitudes among the target group, which would in turn result in physical activity participation. This model, known as the hierarchy-of-effects (HOE) model, was proposed previously for assessing the immediate and media-specific effects of campaigns, but it has not been empirically tested.[4]

The HOE model was developed as part of advertising and marketing theory in the 1960s.[21] The model was brought to public health's attention in the 1980s by William McGuire, a social psychologist interested in attitude development, and it was proposed as a framework to guide public health communications campaigns.[1,22]

This hierarchy is conceptualized as a causal chain of links between proximal variables and endpoints or distal outcomes. Many campaigns collect information on proximal variables, including awareness and recall of the campaign message.[4] The intermediate measures in the VERB campaign were an assessment of understanding of the campaign's message, knowledge of the campaign message, and beliefs about being active. The next stages in the HOE model require measures of attitude, and then measures of efficacy, outcome expectations, and intention. The final endpoints are engaging in physical activity or other appropriate responses such as the trialing of an activity.

The HOE model acknowledges that success becomes more difficult to achieve as the process moves from initial campaign awareness through to attitudinal and behavior change. However, it is useful for planning campaigns, developing relevant intermediate campaign goals, predicting change, and refining communications strategies to optimally affect mid-point variables.[23] Several recent public-sector large-scale mass-media campaigns to promote physical activity have used this specific HOE model in the planning and development of campaign material and in audience targeting.[9,11,12,20,24] Numerous alternate hierarchies of effect models have been proposed, especially in the communications literature, and have proposed alternate structures and ways in which communications exert their effects.[23,25,26] Given that VERB was a typical, pragmatic mass-media public health campaign, in this paper, the analysis has been limited to a specific and empirical test of the classical HOE model that has become commonly accepted in public health campaigns[1] and to an assessment of whether this approach is evidence based in current practice.

The testing of the structure of a HOE model is described, using data from the VERB campaign. VERB campaign data were used to assess the usefulness and predictive validity of the model. This is the one of the first research project to systematically test the HOE model, using data from a purposefully designed evaluation of a population-wide physical activity mass-media campaign.

Methods

Survey Data

The data used in this analysis were from the baseline (Wave 1) and a 12-month follow-up (Wave 2) of the representative Youth Media Campaign Longitudinal Survey (YMCLS) for 2002 and 2003. These were household surveys of youth aged

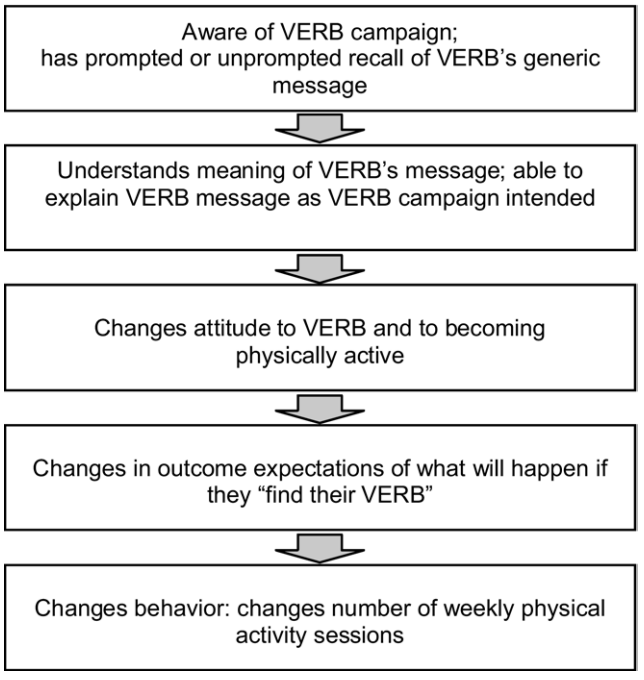

Figure 1. McGuire's hierarchy of effects for mass-media campaigns; adapted to the VERB campaign, 2003.

9 to 13 years and their parents. Data were weighted to the national population of those tweens and adjusted for nonresponse.[18] The survey was approved by the IRB at CDC. Up to two tweens in a household were eligible to be sampled; one parent of each was interviewed. The contact rate, defined as the proportion of households contacted divided by the number of households that that were eligible, was 61%, and the tween interview cooperation rate was 88%.

Measurement

The measures were developed from the VERB campaign questions described previously.[18] For these analyses, measures of awareness, understanding, attitudes, outcome expectations, and physical activity behavior were used. The HOE model that informed this analysis is in Figure 1.

Four categories of VERB awareness were constructed: *unprompted awareness, prompted awareness, other awareness,* and *no awareness.* All tweens were asked, *Have you seen, read, or heard any messages or advertising for getting kids active?* Those who responded *yes* were asked the name of the message; those who answered *VERB* were categorized as having *unprompted awareness.* Those who could not recall the campaign name unaided or responded with a name or brand other than VERB were asked if they had heard of VERB, and those who affirmed they had heard of VERB were categorized as having *prompted awareness.* Tweens who recalled a physical activity campaign, but gave a name other than VERB and could not recall VERB even after being prompted had *other awareness,* and those who did not recall seeing an advertising message about physical activity and could not recall VERB when prompted were categorized as having *no awareness.*

Tweens' understanding of the VERB message was measured through their responses to the open-ended question, *What is VERB all about?* (*VERB about*) and what ideas VERB gave them (*VERB ideas*). Children could provide up to five responses to each question. Responses were assessed and grouped into three categories: *no understanding of the VERB message, low understanding,* or *high understanding of the campaign.* A summary *campaign understanding* variable was created by combining all *VERB about* and *VERB ideas* responses. Tweens who had *other awareness* or *no awareness* of VERB were categorized as having *no campaign understanding.* Those who demonstrated no understanding of *VERB about* and low or high understanding of *VERB idea* or who demonstrated a low understanding of *VERB about* and no or low understanding of *VERB idea* were categorized as having *low campaign understanding.* Children who reported low understanding of *VERB about* and high understanding of *VERB idea* or a high understanding of *VERB about* were categorized as having *high campaign understanding.*

Attitudes and outcome expectations were measured by asking tweens to rank their agreement with a series of questions on a 4-point Likert scale, with 1 being *really agree* and 4 being *really disagree.* The attitude statements concerned whether participation in physical activity on most days would be boring, or fun, and whether they could find an activity they enjoy. To assess expectations, tweens reported their agreement with statements that physical activity on most days would help them make friends, help them spend time with friends, and make them feel good about themselves. Responses to negatively worded questions were recoded in a positive direction.

Attitude and expectation scores were derived, by summing responses to the individual items, and tweens were categorized into *high, moderate,* or *low* levels of attitude and expectation in 2003. If they reported low attitudes in 2003, regardless of attitude level in 2002, they were categorized as having *low attitudes.* If they reported low attitudes in 2002 and high attitudes in 2003, they were categorized as having *low/high attitudes.* If they reported high attitudes in 2002 and high attitudes in 2003, they were categorized as having *high/high attitudes.* The same classification convention was used to derive change in expectations with three final categories: *low expectations, low/high expectations, and high/high expectations.* Measurement properties were assessed in this data set (Cronbach's alpha values were 0.57 for attitudes, and 0.62 for outcome expectations), and test–retest repeatability was assessed elsewhere with rho=0.61 for attitudes and 0.79 for outcome expectations.[27]

Tweens' participation in physical activity was measured in 2002 and 2003 by self-reported sessions of free-time and organized physical activity done outside of school during the week before being surveyed. Free–time sessions and organized sessions were summed to calculate total activity sessions, and they were categorized as inactive (zero sessions), low active (1–6 sessions); or high active (7 sessions or more). A summary 5-category score was used in the primary analyses. Those tweens who were inactive in 2003, regardless of activity level in 2002, were categorized as *inactive,* and those who were inactive or high active in 2002 and low active in 2003 were categorized as *becoming low active.* Tweens who were low active in 2002 and 2003 were *maintaining low active,* and those who were inactive or low active in 2002 and high active in 2003 were categorized as *becoming high active.* Those who were high active in 2002 and 2003 were categorized as *maintaining high active.* Tweens (n=90) whose total activity sessions increased

by 14 or more or decreased by 14 or more between 2002 and 2003 were excluded, because this magnitude of change was considered likely to be a self-report error and not an actual behavior change. For a second analysis, the tweens in 2002 who reported <7 sessions of organized or free-time physical activity in the past week were combined and referred to as *insufficiently active* (n=1232).

Statistical Analysis

As suggested by Rouse,[28] specifying a priori causal pathways using structural equation modeling is an appropriate strategy to test the HOE model. For these analyses, the paths tested were defined as strictly as possible, using the well-defined hypothetical sequence of effects proposed in the McGuire version of the HOE model.[1] Three models were constructed and tested for comparison: (1) the strict HOE model without any second order paths, showing only a linear pathway from awareness to understanding to attitude to expectations and to behavior; (2) an intermediate model that did not follow the cascade of effects from understanding through attitudes and expectations, but included direct pathways from campaign awareness and understanding to physical activity; and (3) a final model that followed the HOE cascade of indirect pathways, but allowed for a direct effect of campaign understanding on physical activity.

All analyses were conducted using the CALIS procedure in SAS version 9.1. Chi-square statistics were calculated to provide tests of the null hypothesis that the model "fits the data." If the null hypothesis is correct, then the chi-squared statistic should be small, and the associated p value should be nonsignificant ($p \geq 0.05$). Four additional goodness-of-fit indices were calculated: the normed fit index (NFI); the nonnormed fit index (NNFI); the comparative fit index (CFI), and the root mean square error of approximation (RMSEA) with corresponding 90% confidence interval. Values for the NFI, NNFI, and CFI >0.9 indicate an acceptable fit between the model and the data. Values for RMSEA ≤0.05 indicate close approximate fit, values between 0.05 and 0.09 suggest reasonable fit, and RMSEA ≥0.10 indicate poor fit.

This analysis extends previous work carried out with these VERB data.[18,29] The major question was to assess whether the proposed HOE structure[1,4,30] fits the VERB campaign evaluation data; specifically whether there is evidence of a cascade effect where proximal variables operate through intermediate mediators in influencing tweens' physical activity sessions. The analytic sample included tweens with matched data in both 2002 and 2003; subgroup analyses were also performed on the data for children insufficiently active at baseline. The latter group may be most responsive to a media message encouraging activity and may demonstrate stronger evidence of HOE than does the whole sample, which includes tweens already active at baseline.

Results

The sample sizes were 3114 for 2002 and 2729 for 2003, and the matched sample used in this analysis was 2364 young people, aged 9–13 years. The matched sample was 48.3% girls and 51.7% boys, with 38.5% aged 10–11 and the rest aged 12–14 years (in 2003). Distributions on the key variables used in the HOE model testing are shown in Table 1. For VERB awareness, 1 in 5 showed *unprompted awareness* of the campaign and more than half reported *prompted awareness*. Understanding of the VERB message was high for 52% of the sample. The majority showed high attitude scores and high outcome expectations in both years.

Table 1. Key variables used in the HOE testing model

VERB campaign variable	*n*	%
Sample used in this analysis	2364	100.0
Awareness of VERB		
None	246	10.4
Other	293	12.4
Prompted	1357	57.4
Unprompted	468	19.8
Understanding of VERB messages		
None	630	26.7
Low	496	21.0
High	1238	52.4
Change in attitude		
Low in 2003	70	3.1
Low 2002–high 2003	49	2.1
High 2002–high 2003	2243	94.9
Change in outcome expectations		
Low in 2003	137	5.8
Low 2002–high 2003	142	6.0
High 2002–high 2003	2085	88.2
Change in level of PA		
Inactive in 2003	208	8.8
Become low active in 2003	498	21.1
Maintained low active in 2003	516	21.8
Become high active in 2003	439	18.6
Maintained high active in 2003	703	29.7

Table 2 shows the correlations among the HOE variables of interest. The first part of the table is for the whole matched sample: the strongest correlations found were between awareness and understanding (0.72) and attitudes and expectations (0.25). The second part of Table 2 is confined to results of analyses for children who were insufficiently active at baseline (<7 sessions, n=1232). In general, the correlations were slightly stronger among variables for children insufficiently active at baseline than for the whole sample.

For the whole sample, models were tested that examined the structure of the HOE cascade, exploring awareness, understanding, attitudes, expectations and physical activity in that order. Of the three models tested, the strict linear sequenced HOE model that did not include any second-order paths demonstrated the least good fit (χ^2=80.64, 6 df, p<0.0001; CFI=0.962; NNFI=0.936; NFI=0.959; RMSEA=0.07 [90% CI=0.06, 0.09]). The best-fitting model is shown in Figure 2, χ^2=2.72, 1df, p=0.1, with good model fit statistics: Bentler's Comparative Fit Index=0.999; Bentler and Bonett's non-normed index=0.991; and NFI=0.997[37]; and RMSEA=0.03 (90% CI=0.02, 0.07). The intermediate iteration of the model between the strict HOE model and the model shown in Figure 2 did not fit the data as well (χ^2=7.31, p=0.02). The data in Figure 2 show strong paths from increases in

Table 2. Correlation matrixes, for all study subjects (N=2364)

	Change in level of PA	Change in expectations	Change in attitude about PA	Understanding of VERB message	Awareness of VERB
Change in level of PA	1.0				
Change in expectations	0.04	1.0			
Change in attitude about PA	0.12	0.25	1.0		
Understanding of VERB message	0.11	0.11	0.08	1.0	
Awareness of VERB	0.11	0.10	0.07	0.72	1.0
For children who engaged in <7 sessions of physical activity per week (*n*=1232), 2002					
Change in level of PA	1.0				
Change in expectations	0.10	1.0			
Change in attitude	0.16	0.25	1.0		
Understanding of VERB message	0.16	0.09	0.10	1.0	
Awareness of VERB	0.15	0.11	0.092	0.72	1.0

awareness leading to increases in understanding, but weak and nonsignificant paths from understanding to attitude or expectations. There was a significant path directly from understanding to the physical activity behavior. Tweens who had high or improved attitudes were likely to improve their outcome expectations. However, neither was related to physical activity behavior although the path coefficient from attitude to behavior (0.1056) was stronger than the path from expectations to physical activity behavior (0.0061).

Analyses were then confined to children who were insufficiently active at baseline, and the HOE model was retested. These data are shown in Figure 3, which shows the same paths modeled as in Figure 2. The data fit this model well (χ^2=2.38, 1df, p=0.12), with good model fit statistics: Bentler's CFI=0.998, NNI=0.987, and the NFI=0.998. Overall, the significant paths were similar in those who were insufficiently active at baseline to those observed in the whole sample. Again, the strongest paths were from awareness to understanding, with significant paths from understanding to physical activity. The path coefficients from "understanding" directly leading to the behavior of physical activity were similar here (0.14) to that observed in the whole sample (0.11). The paths from understanding to attitude and expectations were nonsignificant, but the paths from attitude to expectations and from attitudes to physical activity were significant.

Discussion

These analyses provide some empirical evidence to support the HOE model as a cascade, in part, among young people, in response to the VERB campaign. The VERB campaign was well-resourced, and purchased sufficient media time with exposure to distinct campaign messages, to permit testing of the HOE model. There was careful development of proximal and distal indicators items to examine the potential impact of the VERB campaign messages, especially on awareness and understanding, and these were the most closely-related constructs in the model that we examined. Increasing awareness was most likely to lead to increased understanding of the meaning of the VERB message. Increases in understanding did not lead to changes in attitudes and then expectations, as might be expected with a linear sequence of cascading HOE variables. Instead, young people who understood the message were more likely to engage directly in more physical activity, than were those who did not understand the

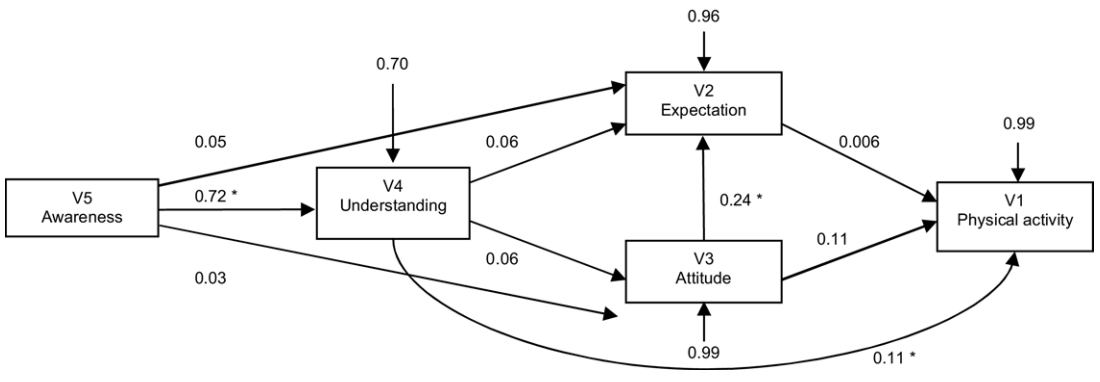

Figure 2. Testing the hierarchy of media effects model for the whole sample.
*p<0.001

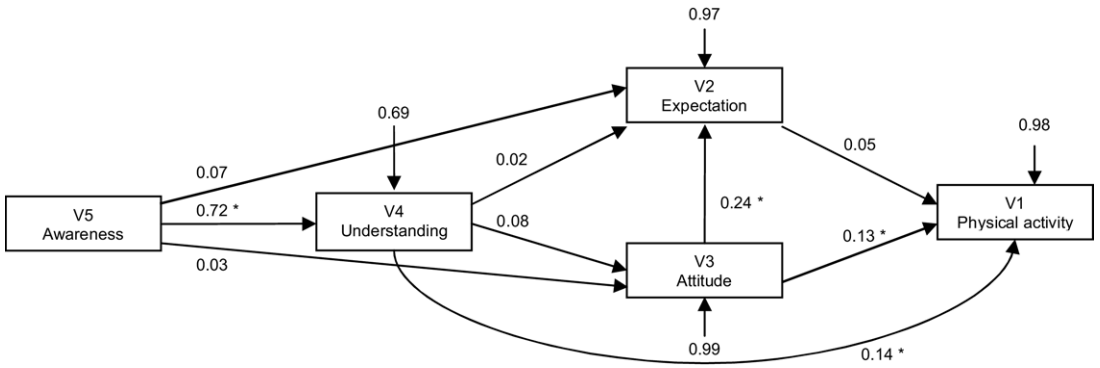

Figure 3. Testing the HOE model, for those at baseline who are inactive (<7 total sessions weekly in 2002).
*$p<0.001$

message. It seems that, especially for those who were inactive, understanding the VERB messages was sufficient to induce behavior change, as measured by weekly sessions of physical activity.

Researchers posit that cues and prompts for physical activity given through media messages, such as those used in the VERB campaign, act to influence behaviors via direct and indirect pathways.[31,32] *Direct* pathways would involve children automatically imitating the physical activity behaviors that were modeled in VERB television advertising (seeing children in the advertisements similar to oneself engaging in the behavior). *Indirect* pathways would be mediated through relevant cognitions; direct paths from message awareness to physical activity were not significant, so *understanding the VERB message* was a necessary mediator of campaign effects. However, for our study sample, attitudes and expectations were not mediators. They were parts of the theoretical model that were not clearly linked to proximal variables. Change in attitude or high attitudes were more likely to lead to improved expectations, or to the behavior (in the inactive sample), but not because of their campaign awareness or understanding. One possible explanation is that the high prevalence of positive attitudes and positive outcome expectations concerning physical activity at baseline allowed little room for change, and hence little scope for these variables to act as mediators. This possibility requires further testing using alternate measures or a population with lower initial attitude and expectation scores.

Testing this HOE model on young people may be different from testing it on adults; most HOE theorizing and putative applications to public health communications were developed for adults.[1,28] It may be that the model should be a different one for young people, and that campaigns that influence cognitive variables such as awareness and 'understanding' may be sufficient for trialing behavior. The way that young people learn may not follow as complex a sequence or cascade of intermediate variables, as is argued to be the case among adults.[1,22] Our analyses provide a different perspective for campaign planners to take into account, and allows, in a multi-year initiative such as VERB, for development of communications strategies that focus on maximizing population brand awareness and message understanding, rather than on persuasive communications with regard to the more distal factors (attitudes and expectations) that are presumed to be in the pathway to behavior change.[23]

As suggested earlier, attitude formation and change may be less important for young people than for adults. Clearly, the HOE model needs to be tested on adults, for whom the proposed cognitive precursors of behavioral change (attitudes and expectations such as those that were measured in the VERB evaluation) are thought to contribute to *indirect* pathways of influence as described above[31,32] and may have a stronger influence, than they appear to have had among the young people in this study.

The strong focus in the VERB campaign on the role of understanding as a direct precursor of behavior and the positive findings using this approach were used in practical ways.[18] For example, initial findings suggested that VERB should move beyond understanding and begin to emphasize the settings and opportunities that support behavior change; therefore, in later years, VERB focused on creating attractive and practical opportunities for activity in various settings and for various cultural groups.

Another explanation of the findings we have reported may lie in the nature of the first year of the VERB campaign: the advertising focused on influencing social norms through promoting the general idea of *getting active*, rather than on changing attitudes. The advertisements had little dialogue; instead, they had visuals of tweens engaging in multiple physical activities and used celebrities to encourage them to *find their VERB*.

The analytic approach that we used has been reported in earlier campaign research. A 1991 paper[33] examined the relationships between multiple-element exposures in a cardiovascular disease prevention cam-

paign and self-efficacy, and then subsequently, the self-efficacy–behavior relationships. This tested a single mediator, which indicates the importance of cognitive factors like self-efficacy, as an intermediate variable mediating the relationship between exposure and behavior. More recent papers have started to explore HOE-like cascades in large-scale campaigns. For example, a preliminary report of a nutrition education campaign found support for McGuire's HOE among adults in rural Mozambique.[34] Another study, carried out in Kansas, examined the determinants of a social-capital promoting behaviors among adolescents following a media campaign.[35] This study supported an exposure—attitude—behavior cascading sequence, using structural equation modeling with data from serial population samples.

Nonetheless, there are limitations in the analyses carried out here. First, we specifically tested a HOE model in current public health usage, and that was used to guide the VERB campaign from the outset. The *hierarchy of change* structure in HOE models has been challenged in communications research, where alternative pathways of influence have been proposed,[23,25,26] such as a model moving from understanding to behavior change and thence to attitude formation. This latter alternative pathway could not be tested with the VERB data, given the baseline ceiling effects of high attitude scores. Nonetheless, although the current analysis provide some new insights that may be relevant to youth media campaigns, the need for alternate path testing and path comparisons remain for all such future research.

Barry[36] indicated that the traditional HOE was likely to remain useful until proved or disproved from an advertising perspective. Further, he suggested that it was incumbent upon managers and policymakers to learn from the established HOE framework, and for researchers to carry out research to 'develop better alternatives.' These comments highlight the usefulness of the present findings, which identify potential ways in which mass communications about physical activity might work in a population of adolescents.

In this paper, VERB was examined as a case study. Further replication of classical HOE and alternate model testing is required, using adult campaign data. Efforts to develop better and alternative theoretical models of how population media campaigns enact their effects[26] will inform the development of better communications theories to guide public health campaign planners.

Finally, mass-media campaigns do not work in isolation. The synergy between the communications efforts targeting adolescents and concurrent innovative programs, policies and facilitatory environmental changes and access to services or programs remain essential to produce sustained public health change.

The findings and conclusions in this paper are those of the authors and do not necessarily represent the views of the CDC.

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