An examination of antecedents to coal miners' hearing protection behaviors: A test of the theory of planned behavior

Brian L. Quick [a,*], Michael T. Stephenson [b], Kim Witte [c], Charles Vaught [d], Steve Booth-Butterfield [e], Dhaval Patel [f]

[a] *Department of Communication, University of Illinois at Urbana-Champaign, Urbana, Il 61801, USA*
[b] *Department of Communication, Texas A&M University, College Station, TX, 77843-4234, USA*
[c] *Department of Communication, Michigan State University, East Lansing, MI 48824*
[d] *Pittsburgh Research Laboratory, National Institute of Occupational Safety and Health, Pittsburgh, PA, 15236, USA*
[e] *Department of Communication Studies, West Virginia University, Morgantown, WV 26501, USA*
[f] *Maria Stopes International in London, W1T6LP United Kingdom*

Abstract

Problem: The National Institute for Occupational Safety and Health's [NIOSH] *National Occupational Research Agenda* (DHHS Publication No. 96 115) reports that approximately 50% of miners will experience hearing loss by age 50, compared to only 9% of the general population. The present investigation examines three antecedents believed to be associated with miner's use of hearing protection. *Method:* A posttest delayed posttest control group field research design was employed to assess antecedents toward wearing hearing protection. *Results:* Following the initial posttest, miners' attitudes and subjective norms were antecedents to intentions to wear hearing protection devices. Also, intentions toward wearing hearing protection predicted hearing protection behaviors. Approximately six weeks later, miners' attitudes and perceived behavioral control were each significant predictors of intentions to wear hearing protection and again, intentions were positively associated with hearing protection behaviors. *Impact on Industry:* Our results indicate that appeals to normative influences may be the most effective antecedent to employ when persuading coal miners to wear hearing protection. However, messages designed to impact attitudes and perceived behavioral control were also effective.

1. Problem

Noise-induced hearing loss affects approximately 30 million workers in the United States on a daily basis (National Institute for Occupational Safety and Health [NIOSH], 1996). While noise is problematic for several occupations, coal miners along with individuals working in agriculture, construction, manufacturing and utilities, and the military are at the greatest risk of experiencing hearing loss due to the noise in each of their respective working environments. NIOSH (1996) reports that approximately 50% of miners will experience hearing loss by age 50, compared to only 9% of the general population. Moreover, this percentage is believed to jump to 70 by the time miners reach the age of 60, according to the same report. The good news is that hearing loss is preventable through the use of ear plugs, ear muffs, and semiaurals (Murray-Johnson et al., 2004; NIOSH, 1996). Applying the Theory of Planned Behavior (TPB; Ajzen, 1991), the present investigation examined antecedents to both intentions and hearing protection behaviors among Pennsylvania and West Virginia coal miners. We begin by providing an overview the TPB.

2. Theory of Planned Behavior

When examining antecedents to behavior change, a commonly used theory is Ajzen's (1985) TPB. Building off of Fishbein and Ajzen's (1975) Theory of Reasoned Action (TRA), this theory provides a more comprehensive depiction of verifiable antecedents for certain behaviors (i.e., wearing hearing protection) than TRA. In addition to examining attitudes and subjective norms as antecedents, Ajzen (1991) identified perceived behavioral control as a predictor of one's behavioral intent. TPB assumes that individuals rationally weigh the rewards and costs of a behavior before performing a task. The theory has been applied to health campaigns promoting a variety of behaviors. For example, Silk, Parrott, and Dillow (2003) used the TPB in guiding their formative evaluation of messages promoting genetically modified foods. The theory has also been applied to evaluating the effectiveness of social norms campaigns concerning binge drinking on college campuses (Campo et al., 2003). The present investigation seeks to apply the TPB to the context of coal miner hearing protection behaviors. Following TPB, a miner's attitude, subjective norm, and perceived behavioral control toward wearing hearing protection are predicted to be positively associated with intentions toward wearing hearing protection (Ajzen, 1985). In turn, intentions to wear hearing protection is hypothesized to be positively associated with wearing hearing protection. Below, we briefly discuss each of the variables comprising the TPB.

2.1. Attitude

One predictor of an intention is one's attitude toward performing a specific behavior (Fishbein & Ajzen, 1975). An attitude is defined as a favorable or unfavorable evaluation of the belief at hand. Attitudes are often shaped by a belief in the severity of the threat at hand. Murray-Johnson et al. (2004) discovered that most miners "reported the concept of hearing loss as potentially scary and frightening" (p. 746). According to the same report, others stated that noise exposure in the mine was "horrible, serious, harmful, permanent and affecting their quality of life" (p. 746). Despite the perceived severity of noise exposure in the mine, these miners believed hearing protection strategies to be only marginally effective (Murray-Johnson et al., 2004). The beliefs, along with evaluations of these beliefs, comprise one's attitude (Fishbein & Ajzen, 1975).

Research reveals that attitudes are a stable predictor of behavioral intentions. Kim and Hunter's (1993) meta-analysis, which consisted of 92 studies, found an uncorrected mean correlation between attitude and behavioral intention of .65. Sheeran and Taylor (1999) and Godin and Kok (1996), meta-analyses of 32 and 56 studies, respectively, found robust positive associations of .45 and .46 between attitudes and behavioral intentions. Thus, we assume that one's attitude toward hearing protection is positively associated with behavioral intentions to wear hearing protection. Thus:

H1. A coal miner's attitudes toward wearing hearing protection will be positively associated with behavioral intentions toward wearing hearing protection.

2.2. Subjective Norm

A second antecedent to behavioral intentions is subjective norms. Subjective norms represent the perceptions that important others think you should or should not perform a specified behavior (Fishbein & Ajzen, 1975). Within the context of miners wearing hearing protection, research suggests that coworkers, management, spouse, and supervisors represent normative influences (Murray-Johnson et al., 2004). Many believe that subjective norms represent a key message design variable as an influential antecedent as is demonstrated in the number of campaigns dedicating considerable effort in appealing to normative influences (Campo et al., 2003). For example, several colleges and universities have incorporated social norms marketing campaigns to curb underage drinking on college campuses (see Lederman et al., 2001; Schroeder & Prentice, 1998). The overriding objective of these campaigns was to correct erroneous perceptions regarding alcohol consumption among college students (Campo et al., 2003). From many of these reports, it appeared that appealing to normative influences was a formidable strategy in health promotion, particularly when your target audience is adolescents (Perloff, 2003).

Both the TRA and TPB treat attitudes and subjective norms as antecedents to behavioral intentions. Although the bulk of this research indicates that attitude is the prevailing predictor, subjective norms also provide a reliable predictor of intentions (Ajzen, 1991). In fact, meta-analytic research indicates a positive association ranging from .34 to .42 between subjective norms and behavioral intentions (Godin & Kok, 1996; Sheeran & Taylor, 1999). Given the established relationship between these variables and in conjunction with the TPB, we put forth the second hypothesis:

H2. A coal miner's subjective norms toward wearing hearing protection will be positively associated with behavioral intentions toward wearing hearing protection.

2.3. Perceived Behavioral Control

After more than 15 years of reliance on attitudes and subjective norms to predict behavioral intentions, Ajzen (1991) added a third antecedent to the equation-perceived behavioral control. Perceived behavioral control is similar to Rotter's (1966) notion of locus of control. However, perceived behavioral control refers to a belief about the degree of control one perceives to have in performing a specific behavior (Ajzen, 1991). Whereas perceived behavioral control is a situational-specific belief, Rotter's locus of control is a personality trait. Rotter's (1966) conceptualizes a person with an internal locus of control as someone who believes that outcomes materialize as a direct result of their behavior whereas someone with an external locus of control attribute outcomes to fate or chance. On the other hand, Ajzen's (1991) perceived behavioral control is concerned with the ease or difficulty one perceives in performing a behavior. As noted by Ajzen (2002), a "closer analysis reveals that perceived control over an outcome or event is independent of the internal or external locus of the factors

responsible for it" (p. 676). Although the conceptualization of perceived behavioral control appeared concrete, Ajzen (2002) acknowledged the ambiguity surrounding this theoretical construct. Through his use of hierarchical modeling, he argued that perceived behavioral control encompassed aspects of both self efficacy and controllability. Accordingly, our conceptualization of perceived behavior control is consistent with his recent writings. Both dimensions of perceived behavioral control were revealed in a recent study that examined miners' perceptions of wearing hearing protection (Murray-Johnson et al., 2004). In doing so, they reported miner concerns ranging "from comfort, hygiene of HPD [hearing protective devices] products, and cost, to their inability to want to make a behavior change" (p. 748). Given these results from approximately 30 miners, we believe examining the relationship between perceived behavioral control and behavioral intentions when promoting hearing protection is important.

Within the context of hearing protection, TPB assumes that if miners believe they can wear hearing protection, then they are more likely to wear hearing protection. Although perceived behavioral control has not received as much support as the aforementioned antecedents, recent meta-analyses of TPB revealed a strong association (r) between perceived behavioral control and intentions ranging from .35 to .53 (see Ajzen, 1991; Godin & Kok, 1996; Hausenblaus, Carron, & Mack, 1997). Following TPB, we expect that miners maintaining perceived behavioral control, both the confidence and ability, will likely report intentions to wear hearing protection. Thus:

H3. A coal miner's perceived behavioral control toward wearing hearing protection will be positively associated with behavioral intentions toward wearing hearing protection.

2.4. Behavioral Intentions

The TPB hypothesizes that behavioral intentions to perform a specific behavior will be positively associated with performing the behavior. Fishbein and Ajzen (1975) define behavioral intention as the likelihood a person will perform a specific behavior. According to TPB, if a coal miner has an intention to wear ear plugs or ear muffs in the mine, then he or she is likely to perform this behavior. With that said, we put forth the fourth hypothesis:

H4. A coal miner's intention to wear hearing protection devices in the mine will be reflected in his or her self-reported behaviors.

To summarize, this project applies the TPB within the context of health messages designed to persuade Pennsylvania and West Virginia coal miners to wear hearing protection in the mines. Following the TPB, we hypothesize that three antecedents will be positively associated with intentions to wear hearing protection-attitudes (H1), subjective norms (H2), and perceived behavioral control (H3). Also, behavioral intentions to wear hearing protection are hypothesized to be positively associated with self-report hearing protection behaviors (H4). Together, these hypotheses are depicted visually in Fig. 1.

3. Method

3.1. Participants and Procedures

The present investigation employed a posttest, delayed-posttest field research experimental design to assess three antecedents believed to be associated with hearing protection behaviors. In doing so, coal miners received two postcards (e.g., either a positive, neutral, or negative affective appeal) within a two-week timeframe via the United States postal service (see Appendix A). Approximately six weeks after the postcards were mailed, miners who had completed the first survey received a second identical survey. For coal miners not returning the second survey, a research firm contacted them via phone to complete the survey. A second custom-printed mining decal was provided to those completing the second survey. Miners randomly assigned to the control condition were not included in this report.

Participants were miners from 23 randomly-selected coal mines in Pennsylvania and West Virginia. The list of mines was provided by the United Mine Worker's Association. During the posttest, all coal miners (N=324) were male. The total number of miners included in this analysis was 254. The average age was 49.24 (SD=6.16) and almost all respondents (98.7%) identified their race as White/European-American with only a slight representation of Black/African-American or Native American. Most miners (89.2%) were married. Regarding educational achievement, the majority of miners had completed high school (49.6%) or some college (23.3%), while others completed some high school (10.4%), vocational school (11.3%), or held a college degree (5.4%). The average amount of time spent working in a mine was 24.84 years (SD=6.82). For the delayed posttest survey, which occurred approximately six weeks later, 191 miners participated.

3.2. Hearing Protection Campaign

Coal miners in the three experimental postcard conditions were mailed two different postcards containing recommendations

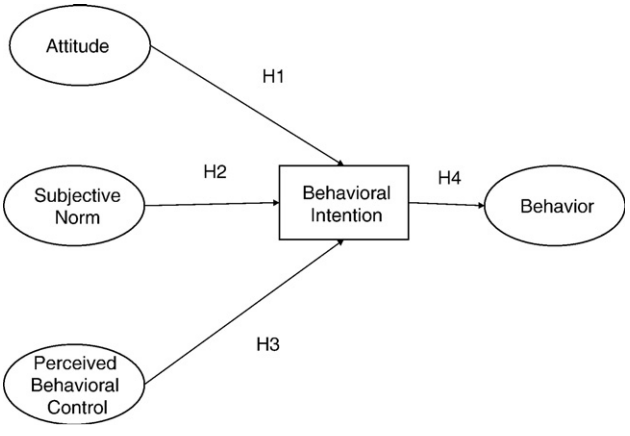


Fig. 1. Hypothesized Structural Model.

for hearing protection while working (for a detailed description of these postcards, see Stephenson et al., 2005). Within a week of receiving the first postcard, miners received a second postcard in the mail. Miners received a survey one week after the second postcard arrived. Along with the questionnaire, miners received both postcards that they had previously received. In all, miners in the treatment conditions received a total of four postcards throughout the campaign. Coal miners in the control condition only received the survey. Lastly, regardless of condition, participants received a cover letter in the survey packet from the United Mine Workers' Association, the labor union that represents the targeted miners, encouraging their assistance with the survey. Miners were asked to complete and mail back the survey in exchange for a custom-printed mining decal. The response rate was 28%.

In order to maximize exposure of the persuasive messages advocating hearing protection (Hornik, 2002), poster-size versions of the postcards were located in high traffic locations inside the mines (e.g., locker rooms, time card sites, drinking fountains). These poster-sized messages were identical to the postcards received by coal miners in the mail. Since the mines were randomly assigned to a condition, they received matching posters and postcards in order to prevent contamination of the stimuli among the three conditions.

3.3. Measures

3.3.1. Attitudes toward hearing protection

Attitudes toward hearing protection formed a modestly reliable scale during the posttest ($\alpha = .68$) and delayed posttest ($\alpha = .63$). On a seven point (1 = *strongly disagree* to 7 = *strongly agree*) scale, miners indicated their attitudes through the following three items: (a) wearing hearing protection is good, (b) wearing hearing protection is bad (reverse coded), and (c) wearing hearing protection is positive.

3.3.2. Subjective norms toward hearing protection

Subjective norms toward wearing hearing protection was assessed on a 1 (*Strongly disagree*) to 7 (*Strongly agree*) scale using the following items: (a) My spouse wants me to wear hearing protection; (b) My supervisor wants me to wear hearing protection; (c) My co-workers want me to wear hearing protection; and (d) Management wants me to wear hearing protection. Together, these four items formed a reliable measure both during the posttest ($\alpha = .80$) and delayed posttest ($\alpha = .81$).

3.3.3. Perceived behavioral control toward hearing protection

Following Ajzen's (2002) recent work, the scale employed in this analysis reflects his operationalization of perceived behavioral control. Specifically, on a 1 (*Strongly disagree*) to 7 (*Strongly agree*) scale, the following four items were used: (a) I am able to wear hearing protection whenever machinery is on; (b) I can wear hearing protection whenever I want; (c) It is easy to wear hearing protection whenever machinery is on; and (d) I can afford to wear the hearing protection I want. This scale achieved a reliable index during the posttest ($\alpha = .73$) and delayed posttest ($\alpha = .72$).

3.3.4. Behavioral intentions

Coal miners indicated their intent to wear hearing protection with the following item on a seven-point (1 = *strongly disagree* to 7 = *strongly agree*) scale: I intend to wear hearing protection regularly.

3.3.5. Hearing protection behaviors

Miners indicated their current behavior by responding to the following three items on a seven point scale (1 = *not at all* to 7 = *all of the time*): (a) I wear hearing protection equipment underground; (b) I wear hearing protection to prevent hearing loss; and (c) I regularly use hearing protection in the mine. These items formed a reliable composite for both the posttest ($\alpha = .86$) and delayed posttest ($\alpha = .87$).

3.4. Data Analytic Strategy for Hypotheses

To test the validity of the hypothesized model, structural equation modeling (SEM) was employed using full-information maximum likelihood estimators in EQS 6.1 for Windows. SEM offers unique advantages over path modeling. SEM affords researchers the ability to visualize and analyze communication as a process (Stephenson, Holbert, & Zimmerman, 2006). Additionally, Stephenson and colleagues argue that SEM allows researchers to test a theoretical model simultaneously as opposed to running a series of individual regressions that examine data one association at a time. Lastly, SEM enables researchers to test direct and indirect effects simultaneously (Holbert & Stephenson, 2003). In testing the proposed model, attitudes, subjective norms, perceived behavioral control, and behavior were treated as latent composite variables (see Holbert & Stephenson, 2002; Stephenson & Holbert, 2003). Behavioral intention was represented as a single item observed variable.

Four tests were used to assess the goodness of fit for the hypothesized models, including the Chi square-distributed goodness of fit (χ^2) to evaluate the omnibus model, Comparative Fit Index (CFI), Standardized Root Mean Squared Residual (SRMR), and the Root Mean Squared Error of Approximation (RMSEA). In determining the adequacy of model fit, structural models with lower χ^2- distributed goodness of fit values that are not significant represent a better fitting model. Additionally, CFI values range from 0 to 1, with better overall fit indicated by higher values. Specifically, Hu and Bentler (1999) recommend CFI values of .95 or higher indicate a good fitting model. To the contrary, good fitting models achieve lower scores on the SRMR and RMSEA. Hu and Bentler (1999) suggest cutoff values close to .09 for SRMR and .06 for RMSEA (see Browne & Cudeck, 1993; Holbert & Stephenson, 2002). The CFI, SRMR, and RMSEA are reported along with the χ^2-distributed goodness of fit for both structural models presented in this investigation.

4. Results

Because this investigation combines data across three treatment conditions, it was important to control for condition when testing the hypothesized model for both the posttest and

Table 1
Zero-Order Correlations and Descriptive Statistics for Posttest Structural Model

		1	2	3	4	5
1	Attitude	1.0				
2	Subjective Norm	.34***	1.0			
3	Perceived Behavioral Control	.34***	.44***	1.0		
4	Behavioral Intention	.40***	.53***	.41***	1.0	
5	Behavior	.34***	.49***	.31**	.69***	1.0
	Mean	-.00	-.01	.00	-.01	-.00
	SD	.79	1.20	1.13	1.45	1.69

Note. *** $p < .01$.

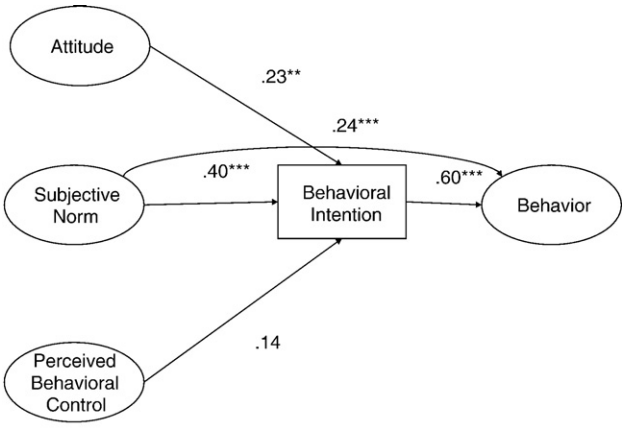
delayed posttest. Because differences between each of the affective appeals of this campaign have been discussed elsewhere (Stephenson et al., 2005), the objective of this investigation was not to reproduce these findings. Rather, the overarching goal of this investigation was to apply TPB to a hearing protection campaign aimed at coal miners to assess sustained association over time. In doing so, identifying antecedents to wearing hearing protection was the primary objective. With that said, it was important to statistically control for the variation due to experimental condition; therefore, two dummy variables for experimental condition were created given the categorical nature of the original variable. Second, we regressed attitude, subjective norm, perceived behavioral control, behavioral intention, and behavior on both dummy variables in SPSS. Then, the unstandardized residuals for these variables, which represent the variance not explained by the experimental condition, were saved and transferred to EQS for the structural equation analyses (e.g., Stephenson & Palmgreen, 2001). In this way, the variables are not adversely affected by any systematic effect attributable to exposure to persuasive messages. The posttest structural model is presented followed by results from the delayed-posttest.

4.1. Posttest Structural Model

Before testing model fit for the posttest, the data were examined for normality. The Mardia's normalized estimate was acceptable at 14.72. We determined that the hypothesized structural model was not consistent with the data, CFI = 1.0, SRMR = .04, RMSEA = .11 (90% confidence interval of .05, .18), χ^2 (3, N = 254) = 12.64, $p < .001$. Following recommendations by the Lagrange Multiplier test, a path was added connecting subjective norms to behaviors. Following this recommendation, the structural model fit the data, CFI = 1.0, SRMR = .01, RMSEA = .00 (90% confidence interval of .00 to .11), χ^2 (N = 254) = 1.36, p = .51. See Table 1 for correlations, means, and standard deviations for this model's variables and Fig. 2 for path coefficients.

4.2. Delayed Posttest Structural Model

When assessing the model fit for the delayed posttest, a Mardia's normalized estimate was 16.75. Following a review of the data, one outlier was dropped from the set bringing the new



Note. *** = $p < .001$. ** = $p < .01$. * = $p < .05$.

Fig. 2. Posttest Structural Model.

Mardia's normalized estimate to 12.28. The revised data revealed that the original hypothesized model did not fit the posttest data, CFI = .99, SRMR = .07, RMSEA = .20 (90% confidence interval of .13 to .28), χ^2 (3, N = 190) = 25.46, $p < .001$. Similar to the posttest data, the Lagrange Multiplier test suggested adding a direct path connecting subjective norms and wearing hearing protection, which resulted in a significantly better fitting model, CFI = 1.0, SRMR = .01, RMSEA = .00 (90% confidence interval of .00 to .14), χ^2 (2, N = 190) = 1.65, p = .44. See Table 2 for correlations, means, and standard deviations for this model's variables and Fig. 3 for path coefficients. To examine differences as well as sustained effects between the variables of interest for the posttest and delayed posttest models, see Fig. 4.

4.3. H1: Attitudes and Behavioral Intentions

The first hypothesis predicted a positive association between attitude toward wearing hearing protection and behavioral intentions to wear hearing protections (Fishbein & Ajzen, 1975). Results support H1. According to the structural model, the path coefficient connecting attitudes and behavioral intent was significant at the posttest ($p < .01$) and six weeks later during the delayed posttest ($p < .05$), thus providing empirical support for TPB (Ajzen, 1991).

Table 2
Zero-Order Correlations and Descriptive Statistics for Delayed Posttest Structural Model

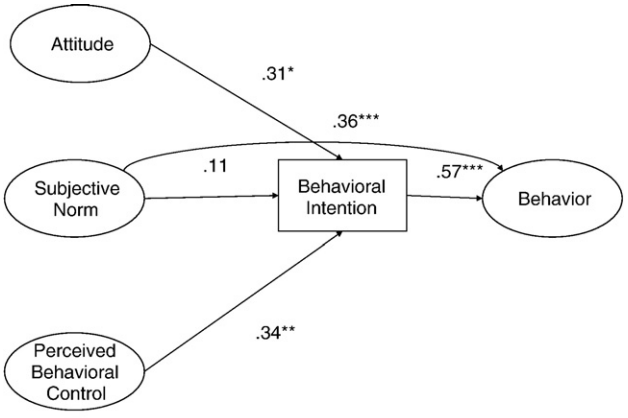
		1	2	3	4	5
1	Attitude	1.0				
2	Subjective Norm	.40***	1.0			
3	Behavioral Control	.47***	.39***	1.0		
4	Behavioral Intention	.48***	.41***	.52***	1.0	
5	Behavior	.40***	.50***	.47**	.67***	1.0
	Mean	−.00	.01	−.00	.03	−.01
	SD	.83	1.27	1.03	1.31	1.62

Note. *** $p < .01$.

4.4. H2: Subjective Norms and Behavioral Intentions

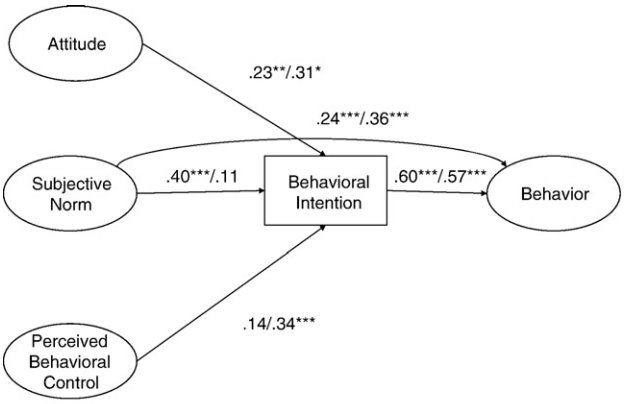
H2 proposed a positive association between perceived normative influences from coworkers, family, management, and supervisors, and intentions toward wearing hearing protection while in the coal mine. Results reveal partial support for the second hypothesis. Following exposure to the persuasive messages, the relationship between subjective norms and intentions to wear hearing protections was positive ($p < .001$). However, this association diminished at the delayed posttest ($p > .05$). Although the majority of research on TRA and TPB indicate that attitudes are a stronger predictor of a specific behavior than subjective norms (see Hale, Householder, & Greene, 2002), results from this investigation revealed that during the initial posttest, subjective norms represented a stronger predictor of behavioral intent to wear hearing protection than attitudes. However, this difference was not replicated during the delayed posttest.

Although mixed results appeared in testing H2, the Lagrange Multiplier test indicated adding a direct path connecting subjective norms to behaviors for both models. Following this recommendation, the revised model fit the data. The path coefficient linking subjective norms and hearing protection behaviors was significant ($p < .001$) for both posttest and delayed-posttest models. Thus, it appears that a direct effect exists between subjective norms and behaviors for both models. In addition, a direct effect emerged between subjective norms and intentions in the initial posttest. However, for the delayed posttest, a non-significant direct effect occurred between subjective norms and intentions, despite the significant association that emerged between subjective norms and hearing protection behaviors. In order to understand this linear association more precisely, a product of coefficient test was performed to test for indirect effects (see Holbert & Stephenson, 2003; MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002). Following Craig's (1936) product of two normally distributed variables table, intentions mediated the association between subjective norms and behaviors ($z = 46.04$, $p < .001$) for the posttest. However, for the delayed posttest, the z-score product for the mediation path between subjective norm and behavior ($z = .03$, $p > .05$) was non-significant, indicating no indirect effect.



Note. *** = $p < .001$. ** = $p < .01$. * = $p < .05$.

Fig. 3. Delayed Posttest Structural Model.



Note. Posttest/Delayed Posttest.
*** = $p < .001$. ** = $p < .01$. * = $p < .05$.

Fig. 4. Differences between Posttest and Delayed-Posttest Structural Models.

4.5. H3: Perceived Behavioral Control and Behavioral Intentions

In addition to attitudes and subjective norms, TPB identifies perceived behavioral control as an antecedent to intentions (Ajzen, 1991). In turn, the third hypothesis predicted a positive association between perceived behavioral control and intentions to wear hearing protection. H3 received partial support. Perceived behavioral control was not significantly associated with intentions to wear hearing protection ($p > .05$) during the posttest. However, during the delayed posttest, the path coefficient for this association was significant ($p < .01$). Therefore, it appears as if exposure to the messages successfully increased the association between perceptions of perceived behavioral control and hearing protection intentions from the outset, thereby providing partial support for TPB.

4.6. H4: Behavioral Intentions and Behaviors

The last hypothesis articulated a positive association between intentions to wear hearing protection and self-reported use of hearing protection such as wearing ear plugs and muffs. Research on both the TRA and TPB has revealed a strong association between both variables (see Ajzen, 1991; Hale et al., 2002; Sheeran & Taylor, 1999). Consistent with this research, both path coefficients at the posttest and delayed posttest revealed a strong positive association between both variables ($p < .001$). Thus, results provide empirical support for the fourth hypothesis.

5. Discussion

The overarching goal of this investigation was to apply TPB to assess three antecedents to coal miners' hearing protection

behaviors. This examination was done within the context of a campaign designed to promote hearing protection behaviors among coal miners. Two objectives were accomplished. First, this examination provided an empirical test of the TPB. A theoretical foundation provides an explanation for why certain messages are effective or ineffective and therefore are instructive in understanding variables that may maximize the effectiveness of a message. A theory, such as the one employed in this investigation, offers practitioners with a roadmap for message design strategies. For these reasons, applying and testing the hypotheses derived from the TPB within the hearing-loss context of coal mines was justifiable. Second, this investigation identified three antecedents to be used in campaigns aimed at increasing hearing protection behaviors among coal miners.

Hearing loss is a major problem for coal miners, as indicated by NIOSH (1996). Given the need for effective promotional messages designed to advocate hearing protection among coal miners it is important to identify key antecedents to this behavior. Once identified, these antecedents can inform message design strategies in the future. The TPB was employed as a theoretical framework to examine the theory's testable hypotheses (Ajzen, 1991). Results suggest that miners' attitudes toward wearing hearing protection are a significant predictor of intentions to wear hearing protection in the mine during the posttest. Six weeks later, attitudes remained a robust predictor of intentions to wear hearing protection. According to existing research, attitudes are frequently the strongest predictor of behavioral intentions (for a review, see Hale et al., 2002). Of the three antecedents, attitude was the only predictor that was significantly associated with intentions at both data collection points. In essence, the association between attitudes and intentions toward wearing hearing protection was sustained over time. This finding mirrors meta-analytic research that demonstrates attitude as the best predictor of behavioral intentions (Godin & Kok, 1996; Kim & Hunter, 1993; Sheeran & Taylor, 1999). Although we are unaware of existing research applying the TPB within the present context, research on TRA and TPB consistently demonstrates the predictive nature of attitudes on intentions (Moan & Rise, 2005; Sutton, 1998).

Perhaps one of the most interesting findings that emerged in this evaluation was the role of subjective norms in predicting hearing protection intentions. At the initial posttest, results revealed that subjective norms were the most robust predictor of behavioral intentions to wear hearing protection. However, at the delayed posttest six weeks later, the association between subjective norms and intentions, disappeared. Although this finding came as a surprise, subjective norms achieved a direct effect on hearing protection behaviors at both the posttest and delayed posttest. While a formal test of mediation demonstrated that intentions did mediate the relationship between subjective norms and behaviors initially, this indirect effect was not supported during the delayed posttest. It is worth noting that of the three antecedents, subjective norms was the only variable directly associated with behaviors. This finding makes sense given the camaraderie amongst coal miners (see Murray-Johnson et al., 2004). Coal miners put their lives on the line on a daily basis and in doing so entrust their fellow miners to assist them in completing arduous and dangerous tasks. Future campaigns can incorporate findings from this study into their message design strategies by emphasizing normative appeals. More specifically, messages should emphasize that co-workers, supervisors, and spouses support their hearing protection behaviors in the mine. Based on an earlier study with this cohort of miners, messages employing positive-affect messages appear to be the most persuasive (Stephenson et al., 2005). Future research should examine the effectiveness of coupling positive affect messages with the aforementioned normative influences.

Although the TPB suggests that perceived behavioral control is a significant predictor of behavioral intentions (Moan & Rise, 2005; Norman & Conner, 2006), this was not the case during the initial posttest. During the posttest, a non-significant association emerged, albeit positive, between perceived behavioral control and intentions to wear hearing protection. However, during the delayed posttest six weeks later, perceived behavioral control was positively associated with intentions to wear hearing protection. These findings suggest that encouraging miners to wear hearing protection through the dissemination of postcards and posters can increase the association between perceived behavioral control and intentions over time. Ease of usage and costs have been identified by coal miners as major barriers to wearing hearing protection (Murray-Johnson et al., 2004). Therefore, creating messages designed to reduce these barriers appears reasonable and achievable. Findings from the present study indicate that many of these perceived barriers can be reduced through the dissemination of postcards and posters. Furthermore and perhaps most encouraging from a health campaign standpoint, both of these promotional efforts were achieved with minimal costs.

The fourth hypothesis predicted a positive association between intent to wear hearing protection and hearing protection behaviors. Consistent with Fishbein and Ajzen's (1975) hypothesis, H4 was supported both at the posttest and delayed posttest. Coal miners intending to wear hearing protection also reported wearing hearing protection. This finding complements meta-analytic work demonstrating a significant association between intentions and behaviors (Ajzen, 1991; Kim & Hunter, 1993).

6. Limitations

Despite putting our best foot forward to design an internally and externally valid experiment to assess three antecedents of hearing protection intentions among coal miners, a few limitations hinder the generalizability of these findings. For starters, the initial response rate was low. Given the low response rate, a reasonable conclusion to draw is that the sample was comprised of miners maintaining a vested interest in hearing protection. While the initial response rate was low at the posttest, the follow-up mail survey six weeks later resulted in the loss of 78 miners. Although the response rate was a disappointment, the response rate garnered within the present

study is not uncommon when mail surveys are employed (Frey, Botan, & Kreps, 2000). Another limitation within the present study rests in the single-item measure to assess intentions to wear hearing protection. In an attempt to secure and retain as many coal miners as possible, survey length was abbreviated wherever possible and thus resulted in the single-item measure above. Future research should seek to incorporate multiple items to measure intentions. Future research should also examine if locus of control (Rotter, 1966) moderates the relationships observed in this investigation. With a better understanding of how locus of control impacts coal miners' intentions and subsequent hearing protection behaviors, practitioners will be better equipped to segment audiences on this trait, and as a result, design more effective messages promoting hearing-protection behaviors.

7. Impact on Industry

The success or failure of a health campaign is contingent on multiple factors such as resources, message quality, exposure, evaluation, and formative research (Backer, Rogers, & Sopory, 1992). The motivation behind this investigation was to apply an established theory to better understand three potential antecedents to intentions toward wearing hearing protection among coal miners. In doing so, we are now better situated to identify antecedents associated with this life-improving behavior for coal miners. The TPB provided a conceptual understanding for which variables are associated with hearing protection usage by coal miners.

In an earlier report documenting the effectiveness of the postcard and poster intervention, Stephenson et al. (2005) found that coal miners exposed to either the positive- or neutral-affect messages reported greater hearing protection behaviors compared to those exposed to the negative-affect message for both the posttest and delayed posttest. Additionally, the positive-affect message, compared to the neutral- or negative-affect messages, was more effective in reducing defensive mechanisms (e.g., defensive avoidance) from occurring. In short, the campaign was effective for miners exposed to the neutral- and positive affect messages. The negative-affect messages were not effective at mobilizing increased hearing protection among miners. Although these results presented a comprehensive summative evaluation of the campaign utilizing three different message appeals, the report did not provide practitioners interested in promoting hearing protection with theoretically-grounded antecedents associated with coal miners wearing hearing protection. This investigation sought to identify key antecedents to wearing hearing protection. Below, we provide three recommendations from this investigation.

We have three recommendations for campaigners interested in promoting hearing protection among coal miners. First and most importantly, coal miners' self-report behaviors appear to be most influenced by their co-workers, management, spouse, and supervisors. Promotional messages encouraging hearing protection should incorporate these individuals as credible spokespersons. In a similar vein, normative appeals should be used in hearing protection promotional materials. However, both message strategies should undergo pilot testing to ascertain their perceived effectiveness. Second, miners' attitudes provide a robust predictor of intent to wear hearing protection both initially and were sustained over a six-week period. Reinforcing the benefits of wearing hearing protection will go a long way in bolstering one's attitude toward wearing hearing protection and should continue to be included in future hearing protection campaigns. Stephenson et al. (2005) discovered that positive-affect messages, as opposed to negative- and neutral-affect appeals, proved to be the most effective in promoting hearing protection; therefore, framing messages using a gain-framed approach appears to be better than a loss-framed approach with this particular audience (Kahneman & Tversky, 1979). Again, of the three antecedents of intentions to wear hearing protection, results indicate that attitudes appear to be the most stable and thus should be incorporated into future message design strategies. Third, messages such as "You can talk about hearing loss concerns with your co-workers and learn what they know about how to avoid it" and "You can do your part to protect your hearing by wearing hearing protectors regularly and getting your hearing tested" were effective in increasing perceptions of ease. These messages bolstered perceived behavioral control within the present sample of miners from the initial posttest to the follow-up posttest six weeks later. Given that issues of efficacy have been identified as barriers in the past (Murray-Johnson et al., 2004), future campaigns aimed at increasing hearing protection behaviors among miners should create messages that emphasize issues of perceived behavioral control for coal miners.

In sum, we hope the findings presented in this investigation can be used to inform future hearing protection campaigns to miners and others who function in a noise-filled working environment. Prior to costly and extensive message development, practitioners need to have a sense of which variables are associated with the desirable outcome (Atkin & Freimuth, 2001). Formative research helps enable health campaigners to effectively create messages that will resonate with a well defined target market (Andreasen, 1995; Atkin & Freimuth, 2001; Kotler & Roberto, 1989; Slater, 1995). Although miner perceptions concerning the dangers of noise are well documented (Murray-Johnson et al., 2004) as well as their evaluations of different message appeals (Stephenson et al., 2005), less is known about the antecedents associated with miners wearing hearing protection. This investigation represents an attempt at achieving this objective. Using the three antecedents derived from the TPB, results from this investigation reveal that attitudes, subjective norms, and perceived behavioral control are each positively associated with intentions to wear hearing protection in the mine. It is our hope that we have taken a step toward filling this gap in this investigation.

Acknowledgements

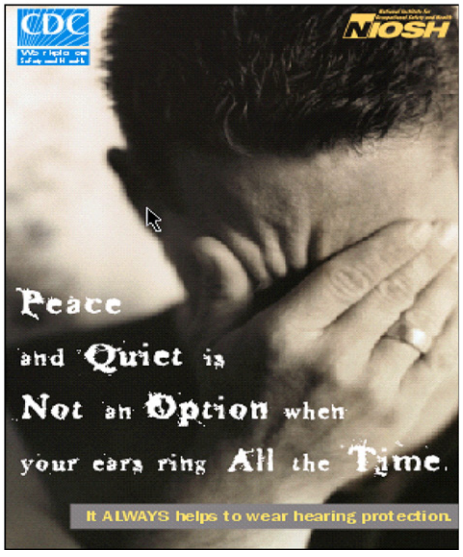
This research was funded in part by a grant from the Centers for Disease Control and Prevention/National Institute of Occupational Safety and Health, Contract BH61-8533.

Appendix A

Positive Emotion Message
Negative Emotion Message
Neutral Emotion Message
Backside of all postcards

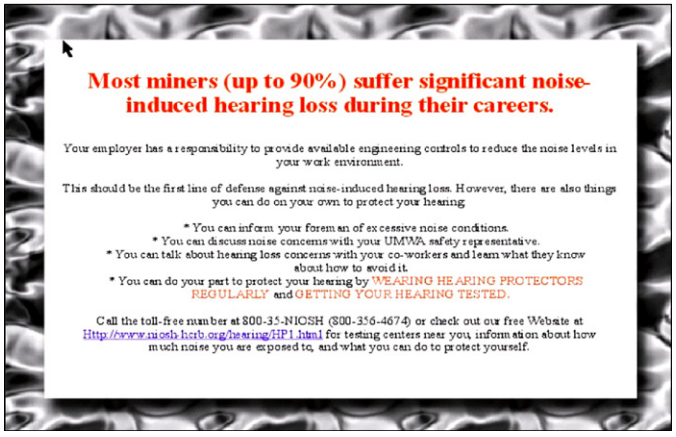
Positive Emotion Message

Negative Emotion Message



Neutral Emotion Message

Backside of all postcards



References

Ajzen, I. (1985). From intentions to actions: A theory of planned behavior. In J. Kuhl & J. Beckmann (Eds.), *Action control: From cognition to behavior* (pp. 11−39). New York: Springer-Verlag.

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, *50*, 179−211.

Ajzen, I. (2002). Perceived behavioral control, self-efficacy, locus of control, and the theory of planned behavior. *Journal of Applied Social Psychology*, *32*, 1−20.

Andreasen, A. R. (1995). *Marketing social change: Changing behavior to promote health, social development, and the environment.* San Francisco, CA: Jossey-Bass.

Atkin, C., & Freimuth, V. (2001). Formative evaluation research in campaign design. In R. E. Rice, & C. K. Atkin (Eds.), *Public communication campaigns* (pp. 125−145)., 3rd ed. Thousand Oaks, CA: Sage.

Backer, T. E., Rogers, E., & Sopory, P. (1992). *Designing health communication campaigns: What works?* Thousand Oaks, CA: Sage.

Browne, M. W., & Cudeck, R. (1993). Alternative ways of assessing model fit. In K. A. Bollen & J.S. Long (Eds.), *Testing structural equation models* (pp. 136−162). Newbury Park, CA: Sage.

Campo, S., Brossard, D., Frazer, M. S., Marchell, T., Lewis, D., & Talbot, J. (2003). Are social norms campaigns really magic bullets? Assessing the effects of students' misperceptions on drinking behavior. *Health Communication*, *15*, 481−498.

Craig, C. C. (1936). On the frequency function of xy. *Annals of Mathematical Statistics*, *7*, 1−15.

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

Frey, L. R., Botan, C. H., & Kreps, G. L. (2000). *Investigating Communication.* Boston, MA: Allyn & Bacon.

Godin, G., & Kok, G. (1996). The theory of planned behavior: A review of its applications to health-related behaviors. *American Journal of Health Promotion*, *11*, 87−98.

Hale, J. L., Householder, B. J., & Greene, K. L. (2002). The theory of reasoned action. In J. P. Dillard & M. Pfau (Eds.), *The persuasion handbook* (pp. 259−286). Thousand Oaks, CA: Sage.

Hausenblaus, H. A., Carron, A. V., & Mack, D. E. (1997). Application of the theories of reasoned action and planned behavior to exercise behavior: A meta-analysis. *Journal of Sports & Exercise Psychology*, *19*, 36−51.

Holbert, R. L., & Stephenson, M. T. (2002). Structural equation modeling in the communication sciences, 1995 2000. *Human Communication Research*, *28*, 531−551.

Holbert, R. L., & Stephenson, M. T. (2003). The importance of analyzing indirect effects in media effects research: Testing for mediation in structural equation modeling. *Journal of Broadcasting & Electronic Media*, *47*, 556−572.

Hornik, R. C. (2002). *Public health communication: Evidence for behavior change.* Mahwah, NJ: Erlbaum.

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling*, *6*, 1−55.

Kahneman, D., & Tversky, A. (1979). Prospect theory: An analysis of decision under risk. *Econometrica*, *47*, 263−291.

Kim, M. S., & Hunter, J. E. (1993). Relationships among attitudes, behavioral intentions, and behavior: A meta-analysis of past research, part 2. *Communication Research*, *20*, 331−364.

Kotler, P., & Roberto, E. L. (1989). *Social marketing: Strategies for changing public behavior.* New York: Free Press.

Lederman, L. C., Stewart, L. P., Barr, S. L., Powell, R. L., Laitman, L., & Goodhart, F. W. (2001). RU SURE?: Using communication theory to reduce dangerous drinking on a college campus. In R. E. Rice & C.K. Atkin (Eds.), *Public communication campaigns* (pp. 295−299)., 3rd ed. Thousand Oaks, CA: Sage.

MacKinnon, D. P., Lockwood, C. M., Hoffman, J. M., West, S. G., & Sheets, V. (2002). A comparison of methods to test mediation and other intervening variable effects. *Psychological Methods*, *7*, 83−104.

Moan, I. S., & Rise, J. (2005). Quitting smoking: Applying an extended version of the theory of planned behavior to predict intention and behavior. *Journal of Applied Biobehavioral Research*, *10*, 39−68.

Murray-Johnson, L., Witte, K., Patel, D., Orrego, V., Zuckerman, C., Maxfield, A. M., et al. (2004). Using the extended parallel process model to prevent noise-induced hearing loss among coal miners in Appalachia. *Health Education & Behavior*, *31*, 741−755.

National Institute for Occupational Safety and Health [NIOSH] (1996). *National Occupational Research Agenda.* DHHS Publication No. (NIOSH) 96 115.

Norman, P., & Conner, M. (2006). The theory of planned behaviour and binge drinking: Assessing the moderating role of past behaviour within the theory of planned behaviour. *British Journal of Health Psychology*, *11*, 55−70.

Perloff, R. M. (2003). *The dynamics of persuasion: Communication and attitudes in the 21st century*, 2nd edition Mahwah, NJ: Lawrence Erlbaum Associates.

Rotter, J. B. (1966). Generalized expectancies for internal versus external control of reinforcement. *Psychological Monographs (General & Applied)*, *80*, 1−28.

Schroeder, C. M., & Prentice, D. A. (1998). Exposing pluralistic ignorance to reduce alcohol use among college students. *Journal of Applied Social Psychology*, *28*, 2150−2180.

Sheeran, P., & Taylor, S. (1999). Predicting intentions to use condoms: A meta-analysis and comparison of the theories of reasoned action and planned behavior. *Journal of Applied Psychology*, *29*, 1624−1675.

Silk, K. J., Parrott, R. L., & Dillow, M. R. (2003). Using theory to guide formative evaluation of "Who's afraid of franken-food?": Implications for health message design. *Communication Studies*, *54*, 1−17.

Slater, M. D. (1995). Choosing audience segmentation strategies and methods for health communication. In E. Maibach & R.L. Parrott (Eds.), *Designing health messages: Approaches from communication theory and public health practice* (pp. 186−198). Thousand Oaks, CA: Sage.

Stephenson, M. T., & Holbert, R. L. (2003). A Monte Carlo simulation of observable-versus latent-variable structural equation modeling techniques. *Communication Research*, *30*, 332−354.

Stephenson, M. T., Holbert, R. L., & Zimmerman, R. S. (2006). On the use of structural equation modeling in health communication research. *Health Communication*, *20*, 159−168.

Stephenson, M. T., & Palmgreen, P. (2001). Sensation seeking, perceived message sensation value, personal involvement, and processing of anti-marijuana PSAs. *Communication Monographs*, *68*, 49−71.

Stephenson, M. T., Witte, K., Vaught, C., Quick, B. L., Booth-Butterfield, S., Patel, D., & Zuckerman, C. (2005). Using persuasive messages to encourage voluntary hearing protection among coal miners. *Journal of Safety Research*, *36*, 9−17.

Sutton, S. (1998). Predicting and explaining intentions and behaviors: How well are we doing? *Journal of Applied Social Psychology*, *28*, 1317−1338.