On a Scale of Health Uncertainty

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Abstract

In this paper, we explicate health uncertainty as the psychological state in which one is incapable of appraising his/her health status and/or making health-related decisions. Health uncertainty comprises four dimensions: information uncertainty, condition uncertainty, efficacy uncertainty, and emotion uncertainty. A 17-item scale was developed as a measurement instrument. Four external variables were used to test the construct validity of the sale. Multilevel confirmatory factor analyses of data from college students (*N*=238) indicated that the scale was unidimensional on the second order. The results indicated that the scale exhibited good internal and external consistency, construct validity, as well as good reliability.

Key Words: *health uncertainty, scale development, scale validation, multilevel CFA, construct validity*

Introduction

The construct of uncertainty has been extensivelystudiedin health communication research to explore two kinds of responses to illness. Health uncertainty is first understood as a psychological state that predicts one's health information behaviors, such as information seeking and avoiding (Barbour, Rintamaki, Ramsey & Brashers, 2012; Bradac, 2001; Brashers et al., 1999; Brashers, 2001; Brashers, Goldsmith, & Hsieh, 2002a; Hurley, Kosenko, &Brashers, 2011). The construct is also linked to one's emotional responses to illness (Brashers, 2001), such as anxiety (Afifi& Weiner, 2004& 2006; Bradac, 2001; Gudykunst, 1995), fear (Babrow, 2001; Brashers et al., 1999, 2002a), and depression (Smith & Christakis, 2008). By and large, scholars tend to agree that the construct of health uncertainty is both theoretically and empirically important. For example, the causal relationship between health uncertainty and its corresponding reactions sheds light on how people make decisions and thus is a building block of theories such as Uncertainty Management Theory (UMT) (Brashers, et al., 1999) and Problematic Integration Theory (PIT) (Babrow, 2001). As such, understanding the ways in which health uncertainty influences individuals' coping strategies offers campaigners, communicators, and practitioners empirical information so that health messages and interventions can be more efficiently designed and tailored.

A clear construct explication and solid operationalization are prerequisite for such utility of health uncertainty. Our review indicated several issues remain in the literature. First issue isthe label for the construct. Scholars have been using "illness uncertainty" to label all types of health concerns (e.g., Babrow, Kasch & Ford, 1998; Mishel, 1988), thereby resulting in a narrowed scope and understanding of uncertainty. The illness-based definition ignores that health uncertainty could also emerge ina variety of array, such as eating habits, exercise habits, obesity, smoking, and/or alcohol consumption (Smith & Christakis, 2008), which are not "illness", but rather behaviors and issues that directly impact one's health.To more comprehensively understand the scope of this construct, it seems more appropriate to use the label *health uncertainty* to assess one's health concern.Second, the utilization of the construct is also criticized for its lack of precision (e.g., Afifi& Matsunaga, 2008) such that researchers are unable to predict whether health uncertainty will be experienced by an individual as a positive emotion (e.g., hope) or as a negative emotion (e.g., fear). As a result, when exactly health uncertainty leads to information-seeking or avoiding is unclear. The third issue is that the operationalization of this construct fails to specify the contents, or the range of meaning of health uncertainty. That is, the essential nature of being uncertain about one's healthas well asthe construct's operational definition still require further refinement.

Thegoal of this paper was to explicate a domain-specific construct and to establish a measurement of health uncertainty. Followed by the introduction, wefirst define the nature of uncertainty as a psychological state in which an individual is incapable of responding tohis/herown health changes. Wethenclarify

the scopes and the issues of operationalizing this construct. Then, a 17-item Health Uncertainty Scale (HUS) is presented to capture the explicated dimensions of health uncertainty. Lastly, the psychometric property of the HUS will be assessed in a nomological network of health-related variables.

Explicating Health Uncertainty

Health Uncertainty as a Psychological State

Uncertainty is a psychological state in which an individual cannot recognize changes over time (Wright, Afari & Zautra 2009) and thus is unable to predict or explain his/her own or others' behaviors (Berger & Calabrese, 1975). This construct is understood as the outcome of the assessment of external evaluations and choices in a given environment or situation (Babrow et al., 1998; Baxter&Braithwaite, 2009; Bradac, 2001; Gudykunst, 2005). Specifically, this external assessment usually occurs in situations where details are ambiguous, complex, unpredictable, and probabilistic (Babrow et al., 1998; Brashers, 2001). Health uncertainty, based on this premise, can be understood as a psychological state in which, due to lack of information, one is incapable of appraising one's health status, or making health-related decisions.

Note that the existing literature usually defines health uncertainty as a cognitive state, implying that one's emotional responses, such as fear and anxiety, are the outcomes of such uncertainty. As explicated herein, the construct of health uncertainty is not confined to cognition. Rather, it is equally plausible that emotional responses can beexisting prior to or coexisting with cognitive uncertainty (see the Lazarus-Zajonc Debate on the primacy of cognition vs. affect, cf. Lazarus, 1999).The rationale lies in that since being sick is an inevitable experience through one's life, one's emotional concerns toward health change should be understood as inherent inhealth uncertainty.

The Scope of the Health Uncertainty Construct

Researchers have proposed several dimensions for concepts that are relevant to health uncertainty. Focusing on the adult patients in the clinic settings andto assess the adult patients' illness uncertainty, Mishel has proposed the Uncertainty Illness Scale (MUIS) (Mishel, 1981, 1988, 1990; Wright et al., 2009) with a four-factorstructure including ambiguity, complexity, lack of information, and unpredictability. Similarly, Babrow and his colleagues (1998) have developed an illness uncertainty framework that synthesizes five dimensions, including complexity, quality of information, probability, structure of information, and lay epistemology.Moreover, Brashers et al. (2003) have proposed the sources of uncertainty in HIV illness in that dimensions of uncertainty are listed as medical uncertainty (i.e., insufficient information about diagnosis, ambiguous symptom patterns, complex system of treatment and care, and unpredictable disease progression or prognosis), personal uncertainty (i.e., complex or conflicting roles, unclear financial consequences), and social uncertainty (i.e., unpredictable interpersonal reactions and unclear relational implications). In general, existing conceptualizations of health-relateduncertaintyconsisted ofillness (e.g., the complexities and probabilities), information (e.g., quality of information and structure of information), and the relational and cultural influences (e.g., lay epistemology) (Babrow, 2001).

There are also issues regarding the conceptualization of health uncertainty. First, some categories overlapped with each other, suggesting that categories are no longer mutually exclusive (Babrow et al., 1998). For example, inBrashers et al.'s (2003) HIV illness uncertainty, one might suspect that information, as a type of sources of uncertainty, actually exists cross all three types of uncertainty. Secondly, either Babrow or Mishel has given more weight on information character than other types of uncertainty, in turn not onlyrestricting the definition of uncertainty but also overlooking other possible dimensions. Finally, some conceptualizations unfairly juxtapose different order of notions (e.g., social contexts and information aspects) within a conceptual framework, which complicates the extent to which the scopes of health uncertainty can be fully explicated.

Based on the aforementioned definitions of uncertainty, this paper contends that the construct explication of health uncertainty should involve both cognition and affect aspects as well as that categories should be mutually exclusive. After reviewing the relevant literatures, our research has expand the scope of its current conceptualization by identifying four most important sub-dimensions of health uncertainty: (1) *information uncertainty*, theinformation characteristics of uncertainty, such as creditability and accuracy; (2) *condition uncertainty*, one's appraisal of his/her health conditions, such as physical status, symptoms and diagnosis; (3) *efficacy uncertainty*, one's perceived ability to recognize solutions, make sense of the current situation, and/or overcome challenges; and (4) *emotionuncertainty*, the affect responses to one's uncertain status, including fear, anxiety and worry.We argue that the strengths of these four aspects are that they areanalytical, not normative, in ways to fit into the criteria of construct explication. Put differently, they are primitive units so that they can sufficiently comprise the whole spectrum of uncertainty situationsas well as can be applied to most health uncertain settings. The

explication of each dimension in health uncertainty is presented below.

Information Uncertainty

Information behavior has been recognized as the key component of health uncertainty (See Babrow, 2001; Brashers et al., 2002a; Barbour et al., 2012), in that individuals are motivated to seek information to reduce uncertainty in earlier research (e.g., Berger, 1986 & 1995; Bradac, 2001; Kruglanski, 1989). Evidence also shows that patients' insufficiency and inaccuracy of the information indeed increased uncertainty (Brashers, Haas, Neidig, &Rintamaki, 2002b). However, later development of such concept suggests that a person might not be motivated to seek information, or to reduce uncertainty (e.g., Hogan, Brashers, Afifi, &Afifi, 2009). Increase in information does not necessarily reduce uncertainty either, because a person may become more aware of her/his lack of knowledge as information increases. In general, information can be defined as 1) things, such as objects and data, 2) knowledge, and 3) the process, which means the act of being informed (Buckland, 1991). As a consequence, being uncertain about the informationmeans thatone is concerned withthequantity and quality regarding these features, namely sufficiency, clarity, completeness, free from error, source expertise or trustworthiness, and consistency (Babrow, 2001).

Condition Uncertainty

Condition uncertainty occurs when people cast doubts on the status of their well-being. This component includes one's adaptive coping ability to evaluate the likelihood and meanings that are relevant to their lives (Bradac, 2001; Brashers, 2001; Wright et al., 2009). It contains a broad range of the possibilities where people attempt to evaluate their health conditions including, but not limited to, physical and mental condition, resource, and susceptibility (to illness/risk). For example, in the face of unknown symptoms, people with HIV/AIDS, or other chronic illness, might have uncertainty related to understanding and assessment of the symptoms, likelihood of illness occurrence, coping strategy and resource availability.

Efficacy Uncertainty

Having the needed information and the resources to facilitate evaluation doesn't necessarily prevent one from being uncertain. In health promotion, self-efficacy, one's capability to produce designated levels of performance that can affect one's life (See Bandura, 1977; 1982; 1990), had been regarded as an important factor that moderatesthe relationship between negative emotions and information seeking (Hogan et al., 2009). Moreover, in health settings, one's self-efficacy is utilized as a mediator to one's outcome assessment and influences one's information behaviors (Hogan et al., 2009; Rains, 2009). Hence, one's self-ability assessment is considered as an important part of uncertainty.Such uncertainty is concerned with one's abilities to make sense of situation, to recognize the utilities of a solution, to overcome barriers, and, finally,to recover from the current situation.

Emotion Uncertainty

Finally, health uncertainty also has an affective component. First, the emotion fear is the consequence of both physiological arousal and subjective experience, resulting from perceptions of threat (Champion et al., 2004). Second, anxiety is a feeling of nervousness and/or unease about an uncertain outcome. In health settings, health anxious individuals would not only display dysfunctional patterns of response to illness information, but also are deficient in protective coping strategies (Hadjistavropoulos, Craig, & Hadjistavropoulos, 1998). Third, closely related to fear and anxiety, worry is defined as a chain of thoughts to negatively engage in mental problem-solving on an issue whose outcome is uncertain. Thus, it is expected that an individual with health uncertaintywould also be worried about his/her uncertainty as well. These uncertain affective states are presumably intertwined with the cognitive domains of health uncertainty, meaning that cognitive uncertainty might be the antecedents of these affective states, which in turn might intensify the cognitive assessments.

Operationalization of the Health Uncertainty Scale

Based on the above explication, we developeda 17-item scale of health uncertainty to capture the four sub-dimensions, with some items adapted from Mishel's Uncertainty in Illness Scale (MUIS) (Albertsen, 2009; Babrow et al., 1998; Mishel, 1981, 1988, 1990), Table 1 presents the items for the proposed four factorsof HUS, the response options are 5-point Likert scales (1= *strongly disagree,* 5=*strongly agree*).

Table 1 *Scale Items and Factor Structure*

Factor	Items
Information Uncertainty	1. I am not sure whether or not the information is enough. 2. I am not sure whether or not the information is correct. 3. I am not sure whether or not the information is clearly presented. 4. I am not sure whether or not the information has multiple meanings/interpretations. 5. I am not sure whether or not I should believe the information.
Condition Uncertainty	6. I am not sure that I have the ability to understand my health status. 7. I am not sure whether or not I am sick. 8. I am not sure what happened to me regarding my illness. 9. I am not sure where I can find the resources or support to help me. 10. I am not sure should I feel positive or negative to my current situation.
Efficacy Uncertainty	11. I am not sure how likely my symptom/illness will go worse. 12. I am not sure that I have the ability to use the resources/information to make decisions. 13. I am not sure whether or not I can overcome the difficulties that prevent me from getting well. 14. I am not sure whether or not I have the ability to recover from my current situation in the future.
Emotional Uncertainty	15. I am not sure should I feel fearful to my situation. 16. I am not sure should I feel anxious about my situation. 17. I am not sure should I worry about my situation.

Data were collected to assess the factor structure and psychometric property of the HUS and to validate the scale. The construct validity of the scale was assessed in a nomological network that consisted ofthe following variables. First, health literacy is the notion to evaluate the degree to which an individual's capability of obtaining, processing, and understanding health messages (e.g., Baker, Williams, Parker, Gazmararian, &Nurss, 1999; Norman & Skinner, 2006; Parker&Gazmararian, 2003). Since the health uncertainty construct also possesses the characteristic of information appraisal and efficacy, it is expected that people with higher health literacy should be less uncertain in the face of their health concerns. Based on this rationale, our first hypothesispredictedthat health uncertainty would be negatively associated with health literacy (H1), meaning that higher one's health uncertainty is, the lower his/her health literacy should be. Next, perceived susceptibility is understood as the likelihood that one feels at risk for experiencing the health threat (Witte& Allen, 2000). With the consideration ofits appraisal nature, we hypothesized that health uncertainty would be positively associated with perceived susceptibility (H2).In light of the second hypothesis, we also predicted that health uncertainty should be positively associated with perceived severity (H3), whichis defined asthe magnitudes of harm expected from the threat (Witte& Allen, 2000; Weinstein, 2000). Forth, research on uncertainty management suggests that uncertainty is associated with a series of information behaviors. Information management, in particular,refers to an individual's information scanning, seeking, and/or avoiding behaviors (e.g., Brashers et al., 2002a; Shim, Kelly,&Hornik, 2006).In response, we contend that it is the joint function of the uncertainty level and one's threshold for uncertainty tolerance that determines information management. Thereby, we hypothesized that health uncertainty should not be correlated with information management behaviors such as information scanning (H4a) orinformation seeking (H4b). In sum, these variables and predictions were considered informative in ways that not only provide the conceptual comparisons among multiple concepts but also allow us to precisely investigate the scopes of health uncertainty.

Method

Selection of Health Topics

According to the American College Health Association (ACHA) (Wyckoff, 2010), undergraduate students are concerned with a variety of health issues, including insufficient sleep, nutrition and weight management, mental illness and depression, infection and the flu, insufficient exercise, and STDs. A preliminary pilot survey (N=60) of undergraduate students from introductory communication courses at University of XXX was conducted to access the major

health concerns of the students where the sample were to be drawn for the data collection. Based on the ACHA list and results from the pilot survey, three health issues were selectedas the primary foci of the current study: eating health, mental health, and the flu. These three issues ranged in severity as well as susceptibility. This strategy cannot only ensure that our participants have sufficient knowledge and experiencetoward those health conditions, but also help us more comprehensively assess the nature of health uncertainty. A more detailed description ofeach health topic is addressed in Appendix A.

Participants

Participants in the main studywere 238 students (M age = 19.50, SD = 1.63) enrolled in the introductory communication theory classes at University of XXX, who did not participate in the pilot survey. By completing this study, students could fulfill course requirements and/or receive extra credit. The sample was composed of 83 (34.9%) males and 155 (65.1%) females. Among them, the majority was white (79.4%), black Americans constituted 8.0% of the sample, Asian Americans 6.7%, Hispanic/Latino 2.9%, and American Indians 0.8%. In addition, 1.7% identified themselves as "other" races. Participants were requested to answer all questions through an online questionnaire.

Procedure

After signing the consent forms, respondents were asked to answer the questions from three health settings, followed by the sequence of eating health, mental health, and the flu infection respectively. In each health uncertainty setting, participants further answered the questions on perceived severity, perceived susceptibility, and information management. Questions about health anxiety and health literacy were asked after the questions in the three health settings were completed. Finally, participants were asked to provide basic demographic information. In addition to age, ethnicity, and gender, this survey also collected participants' current and past health status information (i.e., participants were asked to self-report if they had experienced any of the illnesses that were mentioned in the three health uncertainty settings during the past six months) and information regarding their socioeconomic status (e.g., parents' education background, parents' occupation status, and household income). These questions were designed in an attempt to exclude possible biases and allow us to examine the associations between health uncertainty and socioeconomic status. All procedures described were approved by the authors' Institutional Review Board.

Measures

Health literacy. Health literacy was measured using a 5-point Likert scale (1 = *strongly disagree*, 5 = *strongly agree*). Modified from eHEALS (Norman&Skinner, 2006), this eight-question measure was used to evaluate each respondent's capacity with regard to health information comprehension ability and seeking skills. Sample statements of health literacy include, "I know what health resources are available to me" and "I can tell high-quality from low-quality health resources."The alpha reliability of the scale was .93.

Perceived susceptibility. Perceived susceptibility was assessed by the measurement used in Gerend, West, and Aiken's research (2004), except for the item for participants' numeric estimation, since the current study did not provide participants with sufficient information to conduct self-evaluation. This measurement assessed participants' perceived susceptibility in each health setting respectively. A three-question, five-item Likert scale was developed (1 = *strongly disagree*, 5 = *strongly agree*). Sample items for this measure are, "I believe that the chance that I will have an eating problem during my college years is high" and "I believe that my chances of developing an eating problem compared to other students my age are high." The alpha reliabilities for the scale were.86 for eating condition, .89 for mental health, and .87 for flu infection.

Perceived severity. Perceived severity was measured by the questions developed in the researchof Bryan, Aiken, and West (1997). After one irrelevant item that addressed "permanent physical damage" was removed from the original question set, five questions were retained and further modified for this paper. Finally, a five-item Likert scale was used in this study (1 = *strongly disagree*, 5 = *strongly agree*). Sample items listed here are, "I believe that the cost of treating an eating problem is high" and "I believe that an eating problem would seriously affect my school or work."The alpha reliabilities of the scale were.67for the first condition, .73 for the second condition, and .77 for the last condition.

Information management. Information management was measured with an information seeking and scanning behavioral scale (SSB), a 5-point Likert-type measure ("1 = *none*, 5 = *a lot*" for information scanning and "1=*never,* 5=*always*" for information seeking) developed by Shim et al. (2006). In each health uncertainty setting, two main types of questions, information scanning and seeking, were examined. This assessment asked participants ten questions in each setting, with five for scanning and another five for seeking respectively. Sample questions from the SSB are, "How much attention do you pay to information

about health topics in newspapers?" and "How often did you look for information about healthy eating in newspapers during the past 6 months?" The SSB scale is considered as a formative, instead of a reflective scale. That is, the indicators are causes, rather than indicators. Hence, alpha reliability was no longer relevant and not reported.

Socioeconomic status. Socioeconomic status (SES) was measured by assessing three variables: family income, educations, and occupational status (Bradley &Corwyn, 2002). To note that since the outcomes of those indicators among college students were expected too homogeneous to evaluate the variances, participants' parents' SES was assessed. In particular, the annual household income was designed as categorical variables (i.e., less than $20,453, $20,453- $49,777, $49,777- $100,000, or $100,000 - $180,000) (United States Census Bureau, 2012). Parental educations were measured by asking participants' parents' years of education completed (i.e., less than 12 years, 12 years, 13-15 years, or more than 16 years) (Shavers, 2007). Last, occupational status was evaluated by asking participants' parents' employment status (i.e., employed, unemployed, or retired) (Shavers, 2007).

Results

Confirmatory Factor Analysis

Data analysis strategy. Unidimensionality of the HUS needs to be established before its construct validity is assessed. Given the four proposed dimensions, unidimensionality of the HUS needs to be established on the second order, with the following criteria: (a) a first order oblique four-factor model should fit the data and the correlations among the first order factors should be substantial and similar (i.e., a simple factor structure), and (b) statistical equivalence has to be established between the first order four-factor model and a second order single-factor model.

Recall that each participant responded to the HUS scale and the external variables specific to three health topics. This means that the observations were not independent of each other. The strategy of multilevel confirmatory factor analysis/structural equation modeling (Mels, 2004) takes care of this interdependence structure in the data. The xtreg procedure in Stata was used to estimate multilevel models in hypothesis testing (see du Toit& du Toit, 2008 for detailed discussion on multilevel structural equation modeling, and Rabe-Hesketh&Skrondal, 2005 for discussions of multilevel models in general).

Table 2. *Means, Standard deviation and correlation matrix of the health uncertainty items (N=714)*

	Mean	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	2.34	1.06	1.00																
2	2.23	1.01	0.69	1.00															
3	2.33	1.02	0.63	0.76	1.00														
4	2.47	1.07	0.61	0.66	0.67	1.00													
5	2.25	1.06	0.56	0.76	0.69	0.66	1.00												
6	2.18	1.02	0.42	0.38	0.34	0.32	0.32	1.00											
7	2.14	0.90	0.50	0.44	0.44	0.45	0.39	0.62	1.00										
8	1.99	0.96	0.46	0.38	0.43	0.39	0.39	0.38	0.40	1.00									
9	2.38	1.05	0.51	0.42	0.40	0.45	0.36	0.50	0.54	0.42	1.00								
10	2.22	0.98	0.47	0.44	0.44	0.43	0.41	0.49	0.52	0.35	0.56	1.00							
11	2.15	1.00	0.52	0.56	0.53	0.51	0.56	0.41	0.50	0.37	0.47	0.47	1.00						
12	2.05	0.90	0.52	0.49	0.53	0.50	0.50	0.38	0.48	0.45	0.46	0.45	0.62	1.00					
13	2.09	1.02	0.46	0.42	0.44	0.45	0.47	0.34	0.49	0.40	0.47	0.45	0.54	0.57	1.00				
14	1.99	0.94	0.43	0.38	0.44	0.39	0.42	0.33	0.43	0.35	0.42	0.42	0.50	0.59	0.72	1.00			
15	2.18	1.01	0.49	0.42	0.44	0.44	0.43	0.37	0.50	0.37	0.52	0.53	0.48	0.46	0.54	0.52	1.00		
16	2.21	1.00	0.50	0.45	0.48	0.50	0.45	0.40	0.52	0.35	0.50	0.55	0.50	0.46	0.53	0.52	0.76	1.00	
17	2.23	1.05	0.50	0.40	0.41	0.41	0.39	0.41	0.50	0.38	0.53	0.51	0.51	0.47	0.49	0.51	0.75	0.76	1.00

Input and model specifications. Table 2 reports the means, standard deviations and correlation matrix of the 17 health uncertainty items. Note that this is only for information purpose since the interdependence structure in the data was not removed or taken care of in the zero order correlation matrix. Participants' responses to health uncertainty scalewere submitted to LISREL 8.8 for multilevel confirmatory factor analyses with individual specified as the group variable. Basically, a two-group analysis was performed. The difference between a typical two-group SEM model and a multilevel SEM model lies in that the two groups in the former case are independent of each other; while the two groups in the latter are not: Group One estimates the model that is within-subjects and Group Two estimates the model that is between-subjects (with the grouping variable designated). Three multilevel CFA models were estimated: a) a single factor model where all the items were specified to load on a single latent factor (i.e., health uncertainty), b) a first orderfour-factor model, where the items were specified to load on the respective HUS dimensions only and the four dimensions were allowed to be associated with each other; and c) a second order single-factor model, where the four dimensions in model b) were specified to load on a second order factor (health uncertainty), rather than associated with each other.

Criteria for evaluating the models. Four criteria were used to evaluate the overall fit of models in this study. First, the Goodness of Fit Index (GFI) values range from 0 to 1, with the values greater than .90 indicating good fit. Second, the value of Comparative Fit Index (CFI) ranges from 0 to 1, with values in excess of .90 indicating good fit. Third, the values of Root Mean Square Error of Approximation (RMSEA) of .06 or lower indicate good fit,whereas the values of .08 or lower are assumed as reasonable fit (Browne &Cudeck, 1993). Forth, the negative values of Bayesian Information Criterion (BIC) suggest model fit, whereas the positive values show problematic model fit. The differences in BIC of 2 between two modelsare considered as providing some evidence; 6 or more, strong evidence; and 10 or more, very strong evidence for the superiority of model with a more negative BIC value over another (Raftery, 1995).

Factor structure of HUS. Results from the multilevel CFA showed that the first order unidimensional model did not fit the data: $\chi^2(238) = 3871.42$, RMSEA=.17, CFI=.89, GFI=.70, BIC= 2596.02. The first order oblique four-factor model was a good fit to the data: $\chi^2(226) = 1129.80$, RMSEA=.075, CFI=.98, GFI=.91, BIC=-255.22. The associations between the four factors ranged from .65 to .82 and were similar to each other (Right panel, Table 3).

Table 3 *Scale reliabilities and correlation s between the health uncertainty factors and external variables.*

Factor	Health literacy	Perceived susceptibility	Perceived severity	Information scanning	Information seeking	2nd order factor	Information	Condition	Efficacy	Emotion
2nd order factor	−.46***	.14***	.13***	−.004	.03	.94[a]				
Information	−.53***	.08**	.14***	−.02	.04	.78	.91[a]			
Condition	−.39***	.18***	.12***	−.004	−.04	.90	.74	.82[a]		
Efficacy	−.54***	.17***	.12***	.05	.04	.90	.77	.82	.85[a]	
Emotion	−.38***	.13***	.13***	−.04	.08	.83	.65	.79	.76	.90[a]

Note.[a] *Alpha reliabilities*
**p <0.05, **p <0.01, ***p< 0.001*

The second order single-factor model was also a good fit: $\chi^2(230)$=1156.12, RMSEA=.076, CFI=.98, GFI=.91, and BIC=-255.18. The fit indices for the second order single-factor model were almost identical to the first order oblique four-factor model. More importantly, the BIC difference of less than 1 suggests that the two models were statistically equivalent to each other. These results showed that the second order single-factor model was a good fit to the data and acceptable representation of the factors structure underlying the HUS. Therefore, the unidimensionality of the scale has been established at the second order. Figure 1 presents the factor structure and the standardized factor loadings of the scale.

Scale Reliability

The alpha reliability for the HUS within each health topic was .92 for eating concern, .95 for mental health, and .95 for the flu. Alpha if item deleted fell around the scale reliability across the three topics. Reliability was also assessed for each of the first order factors. For information uncertainty, alpha was .88 within eating concern, .92 for mental health, and .93 for the flu. For condition uncertainty, alpha was .73 within eating concern, .87 within mental health, and .83 for the flu. For efficacy uncertainty, alpha was .83 within eating concern, .86 within mental health, and .87 within the flu. For emotion uncertainty, alpha was .85 within eating concern, .92 within mental health, and .93 within the flu. Theseresults provided evidence that 17-item scale was reliable.

Construct Validity. Fourexternal variables were used to examine the construct validity. Series of multi-level models were estimated to predict the composite scores of the HUS, as well as its four sub-dimensions, using the four external variables as predictors, and participants' health status and the demographic variables as controlled covariates (e.g., age, gender, participants' socioeconomic status). The left panels from Table 3 presented the results from the multilevel models.

Health literacy. Health literacy was predicted to be negatively associated with health uncertainty (H1). This hypothesis was supported. As shown in Table 3, the fixed effects coefficientsfrom the multilevel analyses forthe first order HUS factors and the second order factorwere all negative and significant at thep< 0.001 level. In particular, the associations with health literacy were -.53 for information uncertainty, -.39 for condition uncertainty, -.39 for efficacy uncertainty, and -.46 for emotion uncertainty. The similarity across these four coefficients demonstrated external parallelism. Meanwhile, the association between health literacy and second order factor of HUS was -.46, which altogether supported H1.

Perceived susceptibility. The relationship between health uncertainty and perceived susceptibility was expected to be positive(H2). The fixed effects coefficients from the multilevel analyses for the first order HUS factors and the second order factor were positive and significant at the p< 0.01 level. The associations with perceived susceptibility were .08 for information uncertainty, .12 for condition uncertainty, .17 for efficacy uncertainty, and .13 for emotion uncertainty. Again, the similarity across these four coefficients demonstrated external parallelism. The associationbetween perceived susceptibility and the second order factor was .14 atp< 0.001. Therefore, the data provided evidence for H2.

Perceived severity. A positive associationbetween health uncertainty and perceived severity was expected(H3). The fixed effects coefficientsbetween first four factors and perceived severity were all positive and significant, and similar to each other: .14 for information uncertainty, .12 for condition uncertainty, .12 for efficacy uncertainty, and .13 for emotion for emotion uncertainty. Theassociation between perceived severity andsecond order factor waspositively significant (β= .13, p<0.001).

Information management. The associations between health uncertainty and information management were predicted to be non-significant. The fixed effects coefficients for information scanning ranged from -.02 to .05, all nonsignificant. Those for information seeking ranged from -.04 to .08, all nonsignificant as well. Thus, both H4a and H4b were supported, demonstrating discriminant validity for the HUS. However, the opposite directions in these coefficients meant that there was no external parallelism in HUS when it came to information scanning and seeking.

Conclusion

Psychometric Properties of the Health Uncertainty Scale

Defined as a psychological state in which one is incapable of appraising his/her health status and/or making health-related decisions, health uncertainty comprises four sub-dimensions: namely, information uncertainty, condition uncertainty, efficacy uncertainty, and emotion uncertainty. We divide our conclusion into two parts—one focusing on the assessment of measurement instruments in relation to the content

validity, internal consistency, and external consistency (cf. Hunter &Gerbing, 1982), the other part addressing the limitations and applications of the health uncertainty scale based on our data analysis.

In this research, the health uncertainty scale was derived from the explication of uncertainty literature andthe currently existing measurement. We submit that this conceptualization and its operationalization not only exhibit face validity but also present content validity.

First, with regard to the primary method for examining the relationship among its items, confirmatory factor analysis enabled us to conclude that a second order single-factor model provides a good fit to the 17 health uncertainty items based on the following criteria. First, the correlations among first-order factor, with a range from .65 to .82, were all positive and substantial, and similar to each other. Second, absolute fit indices such as RMSEA, CFI, and GFI for the first order four-factor model and second order single-factor model were nearly identical in that the bothmodels received support. Moreover, the BIC indices for both models were negative, indicating the evidence of models fit. Third, the fact thatBIC differences were smaller than 1, which meant the two factor models were statistically equivalent. We argue that the second order single-factor model can be considered as superior because it is more parsimonious. Fourth, the first-order factors exhibited good consistency in their relationships with external variables, thus suggesting a consistent pattern of parallelism. The parallelism was notable with respect to several variables associated with its appraisal characteristics (perceived susceptibility and perceived severity) andefficacy characteristics (health literacy).

Second, evidence for the convergent validity of HUS came from its associations with health literacy, perceived susceptibility and perceived severity. Both the first order factor and the second order factor for the HUS scale were negatively associated with health literacy, and positively associated with perceived susceptibility and severity. Discriminant validity for the scale came from the non-significant associations between information scanning and seeking and the HUS factors. Here, the external variable of health literacy deserved some extra attention. In particular, the coefficientsbetween information uncertainty and health literacy as well as efficacy uncertainty and health literacy were larger than other types of uncertainty (-.53 for information uncertainty and -.54 for efficacy uncertainty). Significantly, those indices enabled us to conclude that uncertainty is not only conceptually related to health literacy in terms of its cognition and efficacy characteristics, but also is conceptually distinct from health literacy in terms of its condition and emotion characteristics. Such evidence for the construct validity of HUS was notable given the fact that the factor structure of the HUS, as well as the associations with the external variables were obtained across three health topics that varied in both susceptibility and severity to the sample.

Limitations and Directions for Future Research

The results of the validation of the health uncertainty scale should be viewed in light of its limitations. First, the three health topics that we proposed in this study mightnot be acute enough to boost the participants' health uncertainty. Even though we are confident claiming the three topics reflect college students' health concerns, whether those concerns are the preconditions of health uncertainty is not yet clear. The topic of mental health concernhad the highest level of perceived severity (M= 3.73, SD=0.80 on a 1-5 point scale) was only moderate. Our participants might be capable of coping with those health concerns on a daily basis without appraising them as real threats. In other words, participants' familiarity with health topics might immunize them from feeling uncertain. College students also tend to be different from the general public in that they are better-educated and in better health, young and prone to optimistic bias (Weinstein, 1980). The results could have been different, had the scale been administered in the context of other health topics. The scale should be further validated in future studies thatadopt a more sophisticated topic choice strategyandfurther conceptualize the differences between health concerns and health uncertainty.

Second, the HUS scale was developed and validated with college samples. Although the health topics are relevant to the sample, it remains an empirical question if the factor structure would hold had adult sample form the general public, and other health topics that are more relevant to that population been used in scale development and validation (cf. Peterson, 2001). The generalizability of the scale will be enhanced when the scale is further validated in future studies that use samples from the general public, and in the context of health topics are more relevant to that population.

Third, the limitation of research design has also to be taken into account. Our participants were asked to answer the health uncertainty questionnaire followed by the sequence of eatinghealth, mental health, and the flu infection. The repeated question-patterns mightresult inparticipant fatigue that biased their responses. On the other hand, such a panel design was considered as cost-effective. With more resources, future studies that use cross-sectional design would avoid this limitation and reduce participant fatigue.

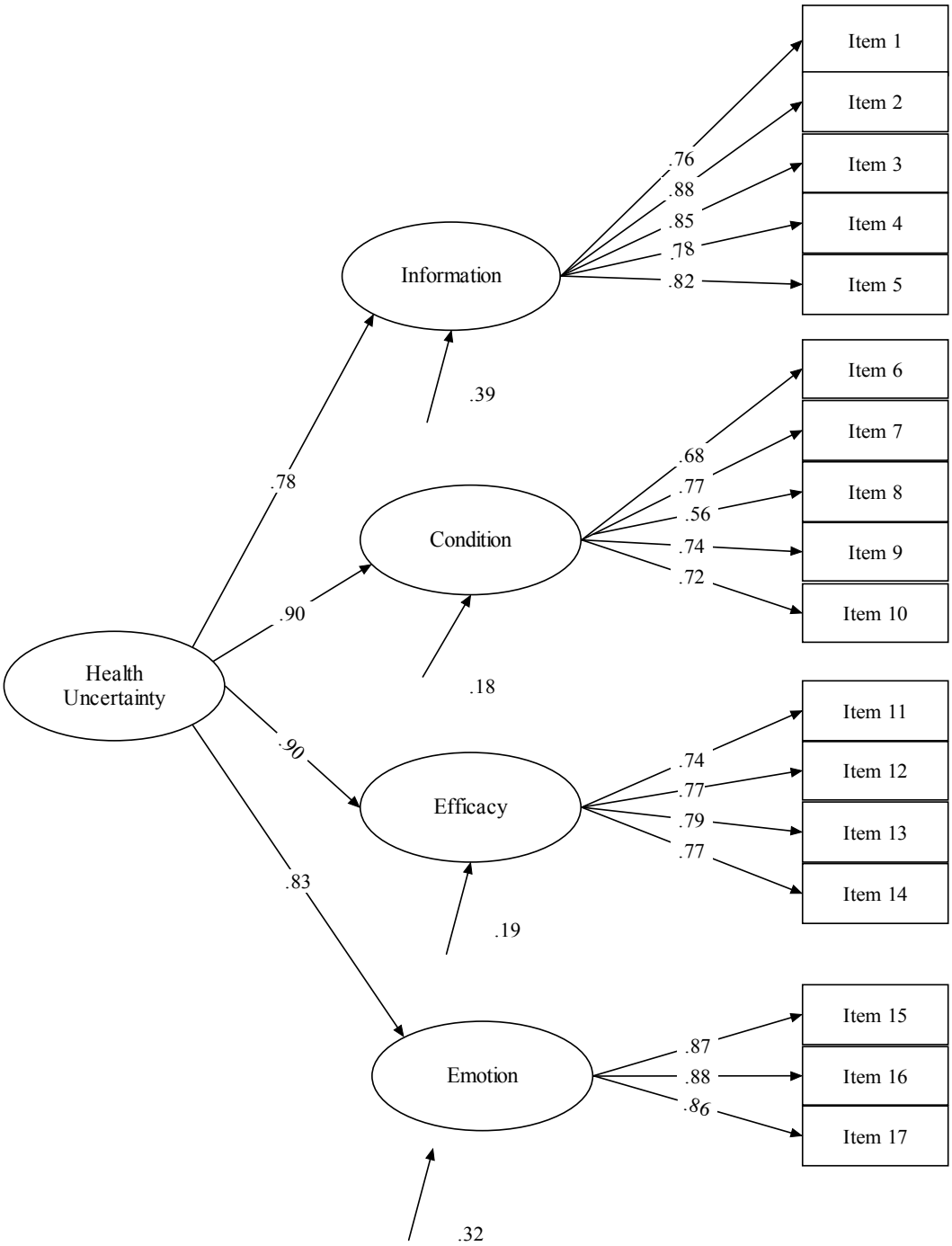
Finally, we turn to the implication of the health uncertainty scale. First, we believe that a valid and reliablemeasurementofhealth uncertainty could inform thefuture health research. For one, with the validation of this scale, the predictions between health uncertainty and other cognitive, emotional, and behavioral construct could be more systematically examined. Also, whilecurrent understanding between uncertainty and its predictions are always regarded as normative (Brashers, 2001; Brashers et al., 2002a), we believe that the health uncertainty scale, with alayered conceptualization and measurement, could assist future research to clarify the causality between specific uncertainty types and their behavioral outcomes. Future researchers, for instance, could examine which type of health uncertainty can predict behavioral responses as well as which types of health uncertainty can account for the emotional responses.

Second, with the HUS scale, we can examine the associations between health uncertainty and the characteristics of diseases in different health settings. To the authors' knowledge, most health studies confine health uncertaintyin a chronic illness setting and overlook the broader picture regarding its relationships with other types of illness, which unfairlyassumes that individuals won't report uncertainty in other conditions. Based on the rationale of the HUS, we believe that it is worth investigatingthe more nuanced associations between health uncertainty and various types of illness. Future research can investigate the implication of health uncertainty scale by looking into other areas, such as substance use, alcohol consumption, and risky behaviors.

Finally, from a more practical perceptive, the implications of the health uncertainty scale will serve as a convenient tool allowing campaigners and health practitioners to better detect individuals' psychological status and changes. This application will also provide us with more information regarding how an effective health message should be tailored and deliveredin targeting at people's health concerns.

In summary, this study is a step toward a better understanding of how the nature of health uncertainty can be examined and measured in health communication research. Our conclusion also suggestsacontinued need to investigate the construct of health uncertainty.

Figure 1 *Standardized parameter estimates of the second order-factor model.*



References

Afifi, W.A., & Matsunaga, M. (2008). Uncertainty management theories: Three approaches to a multifarious process. In L. A. Baxter, Braithwaite, D. O. (Ed.), *Engaging theories in interpersonal communication: Multiple perspectives* (pp. 117-132): SAGE, Los Angeles.

Afifi, W.A., & Weiner, J.L. (2004). Toward a theory of motivated information management. *Communication Theory, 14*(2), 167-190. doi: 10.1111/j.1468-2885.2004.tb00310.x

Afifi, W.A., & Weiner, J.L. (2006). Seeking information about sexual health: Applying the theory of motivated information management. *Human Communication Research, 32*(1), 35-57. doi: 10.1111/j.1468-2958.2006.00002.x

Albertsen, P.C. (2009). Measuring illness uncertainty in men undergoing active surveillance (as) for prostate cancer. *Articles-Patient Care. Paper 25*. doi: 10.1016/j.apnr.2009.08.001

Babrow, A.S. (2001). Uncertainty, value, communication, and problematic integration. *Journal of Communication, 51*(3), 553-573. doi: 10.1111/j.1460-2466.2001.tb02896.x

Babrow, A.S., Kasch, C.R., & Ford, L.A. (1998). The many meanings of uncertainty in illness: Toward a systematic accounting. *Health Communication, 10*(1), 1-23. doi: 10.1111/j.1460-2466.2001.tb02896.x

Baker, D.W., Williams, M.V., Parker, R.M., Gazmararian, J.A., &Nurss, J. (1999). Development of a brief test to measure functional health literacy. *Patient Education and Counseling*. doi: 10.1016/S0738-3991(98)00116-5

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological review, 84*(2), 191. doi: 10.1016/0146-6402(78)90002-4

Bandura, A. (1982). Self-efficacy mechanism in human agency. *American psychologist, 37*(2), 122. doi: 10.1037//0003-066X.37.2.122

Bandura, A. (1990). Perceived self-efficacy in the exercise of control over aids infection. *Evaluation and program planning, 13*(1), 9-17. doi: 10.1016/0149-7189(90)90004-G

Barbour, J.B., Rintamaki, L.S., Ramsey, J.A., &Brashers, D.E. (2012). Avoiding health information. *Journal of Health Communication, 17*(2), 212-229. doi: 10.1080/10810730.2011.585691

Baxter, L.A., & Braithwaite, D.O. (2009). Reclaiming uncertainty: The formation of new meanings in relationships. In W. Affifi & T. Affifi (Ed.), *Uncertainty, information management, and disclosure decisions: Theories and applications* (pp. 18). New York: Routledge.

Berger, C. R. (1986). Uncertain outcome values in predicted relationships uncertainty reduction theory then and now. *Human Communication Research, 13*(1), 34-38. doi: 10.1111/j.1468-2958.1986.tb00093.x

Berger, C. R. (1995). Inscrutable goals, uncertain plans, and the production of communicative action. In C. R. Berger & M. Burgoon (Eds.), *Communication and social influence processes* (pp. 1-28). East Lansing, MI: Michigan State University Press.

Berger, C.R., & Calabrese, R.J. (1975). Some explorations in initial interaction and beyond: Toward a developmental theory of interpersonal communication. *Human Communication Research, 1*(2), 99-112. doi: 10.1111/j.1468-2958.1975.tb00258.x

Bradac, J.J. (2001). Theory comparison: Uncertainty reduction, problematic integration, uncertainty management, and other curious constructs. *Journal of Communication, 51*(3), 456-476. doi: 10.1111/j.1460-2466.2001.tb02891.x

Bradley, R. H., &Corwyn, R. F. (2002). Socioeconomic status and child development. *Annual review of psychology, 53*(1), 371-399. doi: 10.1146/annurev.psych.53.100901.135233

Brashers, D.E. (2001). Communication and uncertainty management. *Journal of Communication, 51*(3), 477-497. doi: 10.1111/j.1460-2466.2001.tb02892.x

Brashers, D.E., Goldsmith, D.J., & Hsieh, E. (2002a). Information seeking and avoiding in health contexts. Human Communication Research, 28(2), 258-271. doi: 10.1111/j.1468-2958.2002.tb00807.x

Brashers, D. E., Haas, S. M., Neidig, J. L., &Rintamaki, L. S. (2002b). Social activism, self-advocacy, and coping with HIV illness. *Journal of Social and Personal Relationships*, 19(1), 113-133. doi: 10.1177/0265407502191006

Brashers, D.E., Neidig, J.L., Cardillo, L.W., Dobbs, L.K., Russell, J.A., & Haas, SM. (1999). 'In an important way, I did die': Uncertainty and revival in persons living with HIV or AIDS. *AIDS care, 11*(2), 201-219. doi: 10.1080/09540129948090

Brashers, D. E., Neidig, J. L., Russell, J. A., Cardillo, L. W., Haas, S. M., Dobbs, L. K., Garland, M., McCartney, B. & Nemeth, S. (2003). The medical, personal, and social causes of uncertainty in HIV illness. *Issues in Mental Health Nursing*, 24(5), 497-522.DOI: 10.1080/01612840390207962

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

Bryan, A. D., Aiken, L. S., & West, L. G. (1997). Young women's condom use: The influence of acceptance of sexuality, control over the sexual encounter, and perceived susceptibility to common stds. *Health psychology, 16*(5), 468. doi: 10.1037//0278-6133.16.5.468

Buckland, M.K. (1991). Information as thing. *Journal of the American Society for information science, 42*(5), 351-360. doi: 10.1002/(SICI)1097-4571(199106)42:5<351::AID-ASI5>3.0.CO;2-3

Champion, V. L., Skinner, C. S., Menon, U., Rawl, S., Giesler, R. B., Monahan, P., &Daggy, J. (2004). A breast cancer fear scale: Psychometric development. *Journal of Health Psychology, 9*(6), 753-762. doi: 10.1177/1359105304045383

du Toit, S. H. C., & du Toit, M. (2008). Multilevel structural equation modeling. In J. de Leeuw& E. Meijer (Eds.), *Handbook of multilevel analysis* (pp. 435-478). New York: Springer.

Gerend, M. A., Aiken, L. S., & West, S. G. (2004). Personality factors in older women's perceived susceptibility to diseases of aging. *Journal of Personality, 72*(2), 243-270. doi: 10.1111/j.0022-3506.2004.00262.x

Gudykunst, W. (1995). Anxiety/uncertainty management theory. *Intercultural communication theory*, 8-58. doi: 10.1016/S0147-1767(98)00005-4

Gudykunst, W. B. (2005). An anxiety/uncertainty management (aum) theory of effective communication. In W. B. Gudykunst (Ed.), *Theorizing about intercultural communication* (pp. 281-322). Thousand Oaks, Calif.: Sage.

Hadjistavropoulos, H.D., Craig, K.D., &Hadjistavropoulos, T. (1998). Cognitive and behavioral responses to illness information: The role of health anxiety. *Behaviour Research and Therapy, 36*(2), 149-164. doi: 10.1016/S0005-7967(98)00014-X

Hogan, T. P., Brashers, D. E., Afifi, T. D., &Afifi, W. A. (2009). The theory of communication and uncertainty management: Implications from the wider realm of information behavior. In T. Afifi & W. Afifi (Eds.), *Uncertainty, information management, and disclosure decisions: Theories and applications* (pp. 45-66). New York Routledge.

Hunter, J. E, &Gerbing, D. W. (1982). Unidimensional measurement, second order factor analysis, and causal models. *Research in Organizational Behavior, 4*(1), 267-320.

Hurley, R. J., Kosenko, K. A., &Brashers, D. E. (2011). Uncertain terms: Message features of online cancer news. *Communication Monographs, 78*(3), 370-390. doi: 10.1080/03637751.2011.565061

Kruglanski, A. W. (1989). *Lay epistemics and human knowledge: Cognitive and motivational bases*. New York: Plenum Press.

Lazarus, R. S. (1999). The cognition-emotion debate: A bit of history. *Handbook of cognition and emotion*, 1-19. doi: 10.1002/0470013494.ch1

Mishel, M. H. (1981). The measurement of uncertainty in illness. *Nursing research, 30*(5), 258-263. doi: 10.1097/00006199-198109000-00002

Mishel, M.H. (1988). Uncertainty in illness. *Journal of Nursing Scholarship, 20*(4), 225-232. doi: 10.1111/j.1547-5069.1988.tb00082.x

Mishel, M.H. (1990). Reconceptualization of the uncertainty in illness theory. *Journal of Nursing Scholarship, 22*(4), 256-262. doi: 10.1111/j.1547-5069.1990.tb00225.x

Mels, G. (2004). *LISREL 8.7 for Windows: Getting started guide*. Lincolnwood, IL: Scientific Software International, Inc.

Norman, C. D., & Skinner, H. A. (2006). eHEALS: The ehealth literacy scale. *J Med Internet Res, 8*(4), e27. doi: 10.2196/jmir.8.4.e27

Parker, R. M., &Gazmararian, J. A. (2003). Health literacy: Essential for health communication. *Journal of Health Communication, 8*(S1), 116-118. doi: 10.1080/713851963

Peterson, R. A. (2001). On the use of college students in social science research: Insights from a second-order meta-analysis. *Journal of Consumer Research, 28,* 450-461.

Rabe-Hesketh, S., Skrondal, A., & Pickles, A. (2005). Maximum likelihood estimation of limited and discrete dependent variable models with nested random effects. *Journal of Econometrics, 128*(2), 301-323. doi: 10.1016/j.jeconom.2004.08.017

Raftery, A. E. (1995). Bayesian model selection in social research. *Sociological Methodology, 25*, 111-164. doi: 10.2307/271063

Rains, S. A. (2008). Seeking health information in the information age: The role of internet self-efficacy. *Western Journal of Communication, 72*(1), 1-18. doi: 10.1080/10570310701827612

Shavers, V. L. (2007). Measurement of socioeconomic status in health disparities research. *Journal of the National Medical Association, 99*(9), 1013.

Shim, M., Kelly, B., &Hornik, R. (2006). Cancer information scanning and seeking behavior is associated with knowledge, lifestyle choices, and screening. *Journal of Health Communication, 11*(S1), 157-172. doi: 10.1080/10810730600637475

Smith, K.P., & Christakis, N.A. (2008). Social networks and health. Annual Reviews of Sociology*, 34*, 405-429. doi: 10.1146/annurev.soc.34.040507.134601

United States Census Bureau (2012). Income, expenditures, poverty, and wealth: Household income. Retrieved on March 30, 2013 from http://www.census.gov/compendia/statab/cats/income_expenditures_poverty_wealth/household_income.html

Weinstein, N. D. (1980). Unrealistic optimism about future life events. *Journal of Personality and Social Psychology, 39,* 806-820. doi:10.1037/0022-3514.39.5.806

Witte, K., & Allen, M. (2000). A meta-analysis of fear appeals: Implications for effective public health campaigns. *Health Education & Behavior, 27*(5), 591-615. doi: 10.1177/109019810002700506

Wright, L.J., Afari, N., &Zautra, A. (2009). The illness uncertainty concept: A review. *Current pain and headache reports, 13*(2), 133-138. doi: 10.1007/s11916-009-0023-z

Wyckoff, W. B. (2010). "5 Big Health Issues on campus." Retrieved on February 25, 2013 from: http://www.npr.org/blogs/health/2010/08/31/129562240/top-5-college-health-issues-this-year