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Aversion to Ambiguity Regarding Medical Tests and Treatments: Measurement, Prevalence, and Relationship to Sociodemographic Factors

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Abstract

Aversion to "ambiguity"—uncertainty about the reliability, credibility, or adequacy of risk-related information—is an important problem that may influence judgments and decisions about medical interventions. Ambiguity aversion (AA) varies among individuals, however, and has been understudied in the health domain. To explore this phenomenon further, we developed a new theory-based measure of aversion to ambiguity regarding medical tests and treatments, and examined the prevalence and association of AA with sociodemographic factors. The "AA-Med" scale was developed using a large survey sample of the U.S. public (n = 4,398), and scale psychometric properties and the population distribution of AA were evaluated. The scale demonstrated acceptable reliability (α = .73) and validity as ascertained by association with respondents' interest in a hypothetical ambiguous cancer screening test. Ambiguity aversion (AA) was associated with older age, non-White race, lower education and income, and female sex. The AA-Med scale is a promising new measure, and AA is associated with several sociodemographic factors. We discuss implications of these findings and potential applications of the scale for future research.

Conflicting information about the benefits and harms of medical interventions has become an increasingly important problem in health care. With the growing emphasis on evidence-based medicine and informed decision making, health professionals have undertaken major

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efforts to evaluate existing evidence regarding the effectiveness of various interventions, identify knowledge gaps, and address areas of disagreement. These efforts have included the development by different professional organizations of clinical practice guidelines that—reflecting the state of evidence—often have been unclear or contradictory. As a result, both clinicians and patients increasingly have been forced to acknowledge and act upon conflicting information about the effectiveness of several interventions. Public awareness of conflicting information has been further heightened by intense media coverage of numerous medical controversies surrounding both well-established interventions such as hormone replacement therapy, and new and emerging technologies such as the Human Papilloma Virus (HPV) vaccine and virtual colonoscopy.

The rise of conflicting information in health care is a matter of great significance because it may have undesirable effects. Conflicting information is a primary source of a specific type of uncertainty that decision theorists have termed “ambiguity”—that is, uncertainty regarding the reliability, credibility, or adequacy of information about risks and the potential outcomes of decisions (Ellsberg, 1961). Ambiguity also arises when risk-related information is incomplete or missing, and has been shown to have several distinct effects on people, promoting pessimistic judgments of the risks and benefits of actions, and avoidance of decision making (Camerer & Weber, 1992; Einhorn & Hogarth, 1986; Kuhn, 1997). This response to ambiguity, known as “ambiguity aversion (AA),” has been demonstrated mostly in decision-making domains outside of health, although growing evidence suggests that it also applies to the health domain (Han, Moser, & Klein, 2006, 2007; Han et al., 2007; Meszaros et al., 1996; Ritov & Baron, 1990; Viscusi, Magat, & Huber, 1999). For example, perceptions of ambiguity regarding cancer prevention and screening interventions have been associated with both lower efficacy perceptions and diminished uptake of these interventions (Han, Moser, & Klein, 2007; Han et al., 2007).

These effects of ambiguity are perhaps not surprising to clinicians and policy analysts, who have voiced concerns that conflicting information might discourage people from undertaking potentially beneficial interventions (Briss et al., 2004; Jepson, Forbes, Sowden, & Lewis, 2001; Raffle, 2001). Yet the concept of ambiguity has not been incorporated into existing theories of health behavior and communication, which deal with perceptions of health risks, rather than the uncertainty surrounding these risks. Furthermore, the true significance of conflicting information regarding medical interventions remains unclear. Ambiguity aversion (AA) does not appear to be a universal phenomenon; in nonhealth domains, a significant minority of people—over 30% in past studies—appear to be tolerant or indifferent to ambiguity (Camerer & Weber, 1992; Einhorn & Hogarth, 1986). This raises the need to understand both the prevalence of aversion to ambiguity regarding medical interventions, and the factors responsible for individual differences in ambiguity aversion. This is a critical task, given the importance of communicating ambiguity as a means of promoting informed decision making (Politi, Han, & Col, 2007).

Little research has been done in this regard, although sociodemographic characteristics such as older age, non-White race, lower education, and lower income have been found to be associated with perceptions of ambiguity regarding medical interventions (Han et al., 2007, in press; Kreuter, Holt, & Skinner, 2004), and might further influence people’s responses to

ambiguity. Individual personality differences may be another important moderating factor. Past research has demonstrated differences in people's tolerance of uncertainty as a more general phenomenon—arising from various sources other than ambiguity (Budner, 1962; Furnham & Ribchester, 1995; Kruglanski & Webster, 1996; Sorrentino & Roney, 2000)—and these differences may influence people's responses to uncertainty arising in the health domain. For example, O'Neill and colleagues (2006) found that differences in "tolerance for uncertainty" predicted emotional distress in a population of women at high risk of breast cancer who received uninformative BRCA1/2 genetic test results. Studying a related personality construct, Brouwers and Sorrentino (1993) found that higher levels of "uncertainty orientation"—that is, individuals' orientation toward novel or uncertain situations—predicted greater information-seeking behavior in response to an uncertain hypothetical health threat. These studies raise the question of whether individuals' aversion to ambiguity—as well as their tolerance for uncertainty more generally—also may be influenced by personality differences.

Much remains unknown, however, about the nature and extent of individual differences in AA in the health domain, since past measurement efforts have not examined responses to ambiguity per se, as a specific subtype of uncertainty. Existing scales from the psychology literature (e.g., the Intolerance of Uncertainty scale [Buhr & Dugas, 2002], Uncertainty Response scale [Greco & Roger, 2001], Tolerance for Ambiguity scale [Budner, 1962; Geller, Tambor, Chase, & Holtzman, 1993]) ascertain people's responses not only to ambiguity but also to numerous other types of uncertainty, and also are not specific to the health domain. In the health services research literature, the Reactions to Uncertainty Scale developed by Gerrity (Gerrity, DeVellis, & Earp, 1990) and modified by Carney (Carney et al., 2004) also ascertains responses to uncertainty in general rather than ambiguity in particular, and although specific to the health domain, is applicable only to physicians. The Mishel Uncertainty in Illness Scale (Mishel, 1981, 1983) measures perceptions of—rather than reactions to—several different types of uncertainty aside from ambiguity and arising in numerous domains including symptomatology, diagnosis, treatment, relationship with caregivers, and prognosis, and is specific to ill patients receiving medical care.

Consequently, although individuals' tolerance of general uncertainty as ascertained through existing generic measures has been shown to predict responses to ambiguous health-related information, it is unclear whether these measures assess differences in ambiguity aversion as well. Furthermore, ambiguity aversion may best be measured in a domain-specific manner, since people may be more or less averse to ambiguity in health than in nonhealth—for example, financial, social—domains. Supporting this possibility, research on a conceptually related personality variable termed "personal innovativeness"—the propensity to adopt innovations at an early stage—has suggested greater predictive utility for domain-specific than for general measures (Armstrong, Weiner, Weber, & Asch, 2003; Goldsmith & Goldsmith, 1996; Goldsmith & Hofacker, 1991; Groeneveld, Sonnad, Lee, Asch, & Shea, 2006).

We undertook the current study to begin to address these needs and issues. The study had two main objectives: (1) to develop and pilot test a measure of aversion to ambiguity regarding medical tests and treatments, and (2) to explore the prevalence of health-related

ambiguity aversion among the lay public, and the associations between ambiguity aversion and sociodemographic factors. The goal was to create a short scale that is specific to the health domain, yet is generic enough—that is, not tied to any particular medical intervention—to be useful in future studies of different interventions. We sought to test an underlying hypothesis that a health-related AA measure with this degree of generality would have predictive validity with respect to individuals' responses to specific ambiguous medical interventions. Based on previous research on the prevalence of ambiguity perceptions (Han et al., in press), we also hypothesized that AA would be associated positively with socio-demographic characteristics including older age, non-White race, lower education, and lower income.

Methods

Data Source and Study Population

The data source was a large national mail survey of the general public conducted by Porter Novelli, a commercial consumer research firm. This survey, known as *Health-Styles*, has been conducted annually since 1995, with the aim of understanding the U.S. public's beliefs, attitudes, and behaviors related to health (Fridinger, Macera, & Cordell, 2002; Gust et al., 2005; Maibach, Maxfield, Ladin, & Slater, 1996; Maibach et al., 2006; Nelson et al., 2008). *HealthStyles* is a component of *Consumer-Styles*, a larger survey of the public's general consumer habits, which is sent annually to members of a voluntary panel composed of approximately 380,000 previously recruited households. Survey respondents are given a $2 incentive and entered into a sweepstakes for cash prizes. The *ConsumerStyles* survey is mailed each year to a nationally representative sample of between 10,000 and 20,000 panel members aged 18 and older, drawn randomly through quota sampling stratified by age, gender, household income, household size, geographic region, and population density. Supplemental mailings are used to oversample low-income and minority individuals and households with children. The *HealthStyles* survey is subsequently mailed to a random sample of those respondents who complete the *ConsumerStyles* survey, and who are offered the same incentives for participation.

For the 2007 survey, the *ConsumerStyles* questionnaire was mailed to 20,000 panel members, and a total of 11,758 members returned completed questionnaires, yielding an overall response rate of 58.8%. The *HealthStyles* survey was mailed to a random sample of 6,600 of these respondents, and a total of 4,398 completed questionnaires (response rate 66.6%) were received.

No information regarding specific characteristics of survey nonresponders was available from the survey vendor, although younger adults (ages 18–34) and adults with less than high school education were found to be underrepresented based on comparison to 2006 U.S. Census data (Porter-Novelli, 2008). Further descriptive analyses were conducted to summarize sociodemographic and health-related characteristics of the study population, using SPSS Complex Samples® (Version 16.0) to adjust for the complex sampling design of *HealthStyles.* In order to provide estimates representative of the general U.S. population, *HealthStyles* data were post-stratified and weighted to the 2006 U.S. Census Current

Population Survey on five demographic variables: gender, age, income, race, and household size.

Scale Development

Conceptual Framework—Scale items were generated based on review of the behavioral decision theory literature on AA and its potential implications in the health domain (Han et al., 2006). As originally conceptualized by various theorists since Ellsberg (1961), ambiguity has several sources, including missing data, unreliability of information, and conflicting information. Most researchers have not distinguished between these sources and their effects, although Smithson (1999) has demonstrated that people are more averse to ambiguity resulting from conflicting information than from other sources. We chose to focus on conflicting information for this reason and because of our primary interest in the effects of conflicting recommendations regarding medical interventions.

Past research has identified several distinct responses to ambiguity (Camerer & Weber, 1992; Han et al., 2006; Politi et al., 2007), which we broadly categorized among three conceptual domains for the purpose of generating potential scale items: cognitive, affective, and behavioral. Cognitive manifestations of AA include heightened perceptions of the risk of the intervention at hand, diminished perceptions of the efficacy of the intervention, and reduced confidence or trust in the intervention. Affective manifestations include heightened worry or fear about the intervention. Behavioral manifestations include avoidance of decision making and diminished uptake of the intervention.

We generated a total of 10 items aimed at measuring these three potential manifestations of AA (see Appendix 1). Items assessing behavioral intentions or willingness were used as proxy measures for behavioral manifestations of AA. Because we wanted a generic AA scale that could apply to many different types of medical interventions—e.g, both diagnostic and therapeutic, for different types of diseases—we worded all items in terms of “medical tests and treatments.” We evaluated comprehension of the “conflicting information” phrase and other aspects of item wording through cognitive testing conducted with nine individuals as part of a separate study. All 10 items were fielded on the *HealthStyles* survey, but they were not grouped contiguously due to spacing specifications determined by the survey administrator. All items used a 5-point response scale numbered from 1 to 5; the “1” and “5” end points of the scale were labeled “strongly disagree” and “strongly agree,” respectively.

Scale Analysis and Item Selection—Factor analysis was conducted to evaluate the dimensionality of the AA-Med scale, and to guide scale reduction with the aim of producing a shorter measure to minimize respondent burden. Confirmatory factor analysis (CFA) was used to test both three-factor and one-factor solutions for the AA scale, using AMOS (version 16.0). The three-factor solution conceptualized AA as consisting of the cognitive (three items), affective (three items), and behavioral (four items) domains that provided the guiding theoretical framework for item development. Model fit was examined using the comparative fit index (CFI >0.90) and root mean squared error of approximation (RMSEA <.09). In the event that CFA failed to demonstrate sufficient fit of these theory-based

solutions, we planned to use exploratory factor analysis (EFA) to ascertain the factor structure empirically.

Scale Reliability and Validity

Internal consistency reliability of the final scale was assessed by Cronbach's alpha. Concurrent validity was evaluated by examining the correlation of the scale with the Personal Innovativeness scale (see Appendix 2), a health domain-specific and conceptually related three-item measure of individuals' propensity to learn about and adopt medical innovations at an early stage (Armstrong et al., 2003). This scale has not been extensively used and demonstrated marginal reliability ($\alpha = 0.60$) in a population of women undergoing genetic counseling for *BRCA1/2* mutation testing; however, higher innovativeness as measured by the scale was found to be a strong predictor of genetic testing uptake. For this reason, and because innovativeness may manifest responses to a specific type of ambiguity —originating from missing information—not measured by our scale, we chose to use the Personal Innovativeness scale to examine concurrent validity.

Criterion validity of the scale was tested by examining the association of scale scores with interest in a specific ambiguous medical intervention. Respondents were presented with two vignettes describing a hypothetical new screening test for colon cancer (Appendix 3). In the first "missing information" vignette, respondents were told that the new test was potentially better than existing tests, but only a few small studies had so far been conducted. In the second "conflicting information" vignette, respondents were told that studies of the screening test gave different results, and experts disagreed about recommending the test. Respondents' interest in having the test in each situation was ascertained using a four-category response scale: "very willing," "somewhat willing," "somewhat unwilling," and "very unwilling." Descriptive statistics and the Wilcoxon signed-rank test were used to compare the distributions of responses to the two vignettes. Univariate analyses of variance (ANOVAs) were used to compare mean scale scores of groups of respondents stratified by the four levels of interest. Hierarchical multivariate linear regression analyses then were conducted to assess the strength of association between AA and interest in the tests, after adjusting for sociodemographic variables.

Ambiguity Aversion: Prevalence, Distribution, and Associations with Sociodemographic and Health-Related Characteristics

Descriptive and univariate analyses were conducted to examine the population prevalence and distribution of AA and its associations with several sociodemographic and health-related variables. Sociodemographic variables included age, race (White, Black, other), education (less than high school, high school graduate, some college, college graduate), and income (under $15 K, $15 K–$24.9 K, $25 K–$39.9 K, $40 K–$59.9 K, $60 K and over), all of which have been associated with perceptions of ambiguity regarding medical interventions (Han et al., in press).

Results

Sample Population Characteristics

Raw frequencies and weighted percentages of sociodemographic and health-related characteristics of the sample population (N = 4,398) are summarized in Table 1. Respondents were drawn from all 50 states, and 61.3% were aged 40 and older, 51.6% were female, and 68.7% were White. Income level of less than $60 K was reported by 61.2% of respondents; 5.9% reported less than a high school graduate level of education, and 30.9% reported graduating from college.

The distribution of responses to the two hypothetical vignettes are shown in Table 2. The proportion of respondents who were “somewhat” or “very” unwilling to have the test was significantly greater (z = 28.187, p <.001) for the conflicting (53.6%) than for the missing (35.0%) information scenario, consistent with the findings of Smithson (1999).

Scale Development

Confirmatory factor analysis (CFA) indicated inadequate model fit for both the three-factor (CFI = .863, RMSEA = .089) and one-factor solutions (CFI = .844, RMSEA = .090) for the 10-item AA scale. Exploratory factor analysis (EFA) therefore was conducted (maximum likelihood, Promax rotation) to examine the factor structure empirically. The EFA suggested a two-factor solution, with the first factor accounting for 31% of the variance and the second factor accounting for 16% of the variance. The first factor was dominated by five items with factor loadings ≥.50 (COG2, COG3, AFF1, AFF2, BEH4; see Appendix 1), and a single item (COG1) with factor loading = .30, which all shared the conceptual similarity of ascertaining general perceptions or feelings in response to ambiguity regarding a medical test or treatment. In contrast, the second item was dominated by two items (AFF3 and BEH1), which each tap respondents’ attitudes regarding the prospect of undergoing the test or treatment. Two other items (BEH2, BEH3) did not load on either factor, and also were conceptually similar to each other in ascertaining respondents’ preferences for information and participation in decision making in response to ambiguity. This content focus may have accounted for the poor loadings of these items, since preferences for information and decision making may be influenced primarily by factors other than ambiguity aversion per se—for example, need for cognition, desire for autonomy. These two items were deleted therefore, leaving a preliminary eight-item scale.

Although the empirical findings suggested a two-dimensional factor structure, several theoretical considerations led us to choose a one-factor solution for further scale evaluation and development. First, although ambiguity aversion can be categorized along multiple response dimensions (e.g., cognitive, affective, behavioral), in theory ambiguity aversion represents a unitary phenomenon, and these various dimensions are conceptually interdependent. Scale reliability was an additional concern given the small number of candidate items—which we purposefully limited in order to create a brief, parsimonious measure, but which resulted in fewer items representing each potential factor (with one factor represented by two items only, α = .65).

Subsequently we examined a single-factor model of the eight-item scale, and found that seven items (COG2, COG3, AFF1, AFF2, AFF3, BEH1, BEH4) retained significant factor loadings (≥.30). COG1 showed low loading and was deleted. To further shorten the scale and to achieve content balance, we also deleted one of the affective items (AFF2) based on content redundancy, retaining the two items that we judged to have the greatest face validity. The final AA-Med scale contained six items (Appendix 1), consisting of two items from each original content domain (cognitive, affective, behavioral). Items were scored and averaged such that higher scores represent greater levels of ambiguity aversion; individuals responding to fewer than five of the six items were treated as missing.

Scale Reliability and Validity

The final six-item AA-Med scale (Appendix 1) had acceptable reliability ($\alpha = .73$), meeting minimal suggested standards ($\alpha > .70$) for group-level measurement (Scientific Advisory Committee of the Medical Outcomes Trust, 2002).

Scale scores showed an expected moderate negative correlation ($r = -.29$, $p < .001$) with scores on the Personal Innovativeness scale, suggesting overlap of these measures but not redundancy. Inferences about concurrent validity, however, should be drawn with caution, since the Personal Innovativeness scale showed poor internal consistency reliability ($\alpha = .33$). Item-total correlations suggested that the 3rd item of this scale ("In general, I am hesitant to undergo a new medical test or treatment") is unrelated to the first two items, which capture information seeking about new tests or treatments—a behavior likely determined by factors independent of innovativeness.

Criterion validity of the scale was supported by analyses relating scale scores to the variable of interest in the hypothetical ambiguous colon cancer screening test. Mean AA scores differed significantly ($p < .001$) between groups of individuals stratified by level of interest, increasing in linear fashion with decreasing levels of interest in the test described in both vignettes (Table 3). This relationship held for both vignettes, in spite of the fact that they dealt with different sources of ambiguity (missing *vs.* conflicting information) and were associated with different response distributions in the sample population. The association was tested further through hierarchical multivariate regression analyses adjusting for sociodemographic characteristics, which all showed significant ($p < .05$) univariate associations with interest in the screening test: age, sex, race (white *vs.* non-white), education (high school graduate or less *vs.* college or more), and income (less than $60 K *vs.* $60 K or more). AA remained a significant negative predictor of interest in the hypothetical colon cancer screening test under both ambiguity conditions: missing information ($\Delta R^2 = .073$, $P < .001$, $\beta = -.362$) and conflicting information ($\Delta R^2 = .067$, $P < .001$, $\beta = -.331$) (Table 4).

Ambiguity Aversion: Prevalence, Distribution, and Associations with Sociodemographic Characteristics

Associations between scale scores and sociodemographic characteristics are shown in Table 5. In general, scores clustered tightly around the median value of 3; however, statistically significant differences in AA were present among respondents grouped by several

sociodemographic variables. To illustrate the magnitude of these differences, we present both mean AA scores as well as the proportion of "high" AA scores, which we defined as greater than or equal to 4 on the 5-point scale, among respondents in the various subgroups.

Consistent with predictions, AA was positively associated with older age although an unexpected curvilinear relationship also was evident, with higher AA for both the oldest and youngest age groups. Also consistent with predictions, higher AA was associated with non-White race and lower education and income. Ambiguity aversion (AA) also was positively associated with female sex.

Discussion

Aversion to ambiguity regarding medical tests and treatments is an important yet underexamined phenomenon, and the current study represents an initial attempt to develop and test a brief, reliable, and valid measure to facilitate future studies of this phenomenon. The 6-item AA-Med scale showed good internal consistency reliability and appeared to tap a construct related to—yet also distinct from—personal innovativeness. The validity of the scale was supported by its association with respondents' expressed interest in a hypothetical ambiguous colon cancer screening test. This finding also corroborates our hypothesis that a measure specific to the health domain, but not to any single disease, medical test, or treatment, could nevertheless predict aversion to ambiguity pertaining to a specific disease intervention.

Moreover, the strong and comparable association of scale scores with responses to ambiguity originating from two different sources—conflicting information and missing information—and associated with different response patterns further supports both the validity of the measure and the generalizability of AA across different sources of ambiguity. This suggests that measuring people's responses to conflicting information alone—as opposed to missing information or other sources of ambiguity—might be sufficient to ascertain AA.

Scale validity was further corroborated by the observed associations between AA scores and various sociodemographic characteristics. As predicted based on prior research (Han et al., in press), AA was associated with non-White race, lower education, and lower income. Ambiguity aversion (AA) also was associated with older age, although a more complex curvilinear relationship was evident, with the youngest respondents also demonstrating greater AA. This finding, as well as the previously unreported differences in AA among women and men, is intriguing but requires further confirmation, since many of the between-group differences in AA scores were relatively small in magnitude, and multiple statistical comparisons were involved. The consistency of our overall findings with past research on socio-demographic predictors of AA, however, supports the validity of the AA-Med scale.

Furthermore, because the same sociodemographic characteristics associated with AA also identify population groups with lower utilization of health services and poorer health outcomes, the observed associations have other important implications. They raise the question of whether AA might mediate or moderate the relationship between

sociodemographic factors and health services utilization, and thereby contribute to intergroup disparities in more distal health outcomes. The observed associations also suggest that ambiguous health information might disproportionately affect individuals of particular population groups, who may thus benefit from targeted efforts to improve their capacity to understand and cope with such information. Our findings raise the need for more research to elucidate the determinants and outcomes of sociodemographic differences in AA, as well as the optimal means of addressing these differences in health communication efforts.

To our knowledge, the scale developed in this study is the only existing and broadly applicable scale measuring responses to ambiguity regarding medical tests and treatments, and provides a potentially useful tool for health researchers interested specifically in this phenomenon. The scale is theory based and focused on ambiguity as opposed to other types and sources of uncertainty, capturing the major manifestations of AA described in the decision theory literature. The conceptual focus of the scale was further refined by factor analyses, which provided empirical guidance for the selection of items related to the AA construct. At the same time, the scale is not overly specific—that is, applicable exclusively to laypersons, patients, or physicians, or to any particular medical test or intervention. Thus the scale could be used to study AA among different people and circumstances. The new scale has the further advantage of being much shorter than existing measures of responses to uncertainty, which consist of 10 or more items.

More research, however, is needed to validate the AA-Med scale using different methods. Ideally, the scale should be validated prospectively with respect to the criteria of actual decisions or other responses to ambiguity in medical contexts. Future studies might also examine convergent and discriminant validity in comparison to existing generic measures of responses to uncertainty, including not only the scales cited previously, but also conceptually related individual difference measures of people's orientation toward information in the face of uncertainty—for example, "need for closure" (Kruglanski & Webster, 1996) and "monitoring and blunting" (Miller, 1987). Such work would help to determine the added value of measuring ambiguity more specifically and in the context of the health domain.

Additional studies also are needed to examine the validity of the AA-Med scale in predicting responses to medical interventions involving different levels of risk or types of outcomes. Past research suggests that the extent of AA may vary depending on the probability of the potential outcomes at hand, or whether these outcomes represent losses or gains (Curley & Yates, 1989; Kahn & Sarin, 1988; Kuhn & Budescu, 1996). This raises the need to validate the scale across a broad range of clinical interventions—high and low risk, preventive, diagnostic, and therapeutic.

The AA-Med scale also needs to be tested with other data sources in different populations. The current data source had the advantage of size and national representativeness, although the lack of information on characteristics of survey nonrespondents—or of people who participate in consumer survey panels versus those who do not—raises some questions of generalizability. Notably, however, past studies using the HealthStyles database have found weighted distributions of obesity, smoking, and other important health-related characteristics

similar to those obtained from nationally representative surveys such as the Center for Disease Control and Prevention's Behavioral Risk Factor Surveillance System (BRFSS; Pollard, 2002).

Studies in other populations would nevertheless be useful to confirm the reliability and validity of the AA-Med scale, and to address other aspects of the data source that may have limited the scale's performance. The fielded items were not clustered together, which likely lowered scale reliability. The HealthStyles questionnaire was long (12 pages) and dealt with numerous topics ranging from alcohol use to genetic testing to vitamin consumption. This raises the possibility of respondent fatigue and acquiescent responding, a likely cause of the observed limited variability in AA-Med scale scores—as evidenced by the tight modal clustering of scores around the midpoint value of 3. This lack of response variability may have accounted for the relatively small—although statistically significant—sociodemographic differences in scale scores, and the relatively low percentage of variance in the criterion variable (interest in the ambiguous colon cancer screening test) explained by AA scores. Future studies might usefully explore whether eliminating the midpoint value, for example, through use of a 4-point response scale, could ameliorate this problem.

In spite of these limitations, the AA-Med scale developed and evaluated in this initial study nevertheless demonstrated adequate reliability and validity. This endorses both the robustness of the new scale and the value of further efforts both to administer the scale under more methodologically optimal circumstances, and to refine its content for specific research applications. For example, the scale might be expanded to measure aversion to ambiguity originating from sources other than conflicting information, or to focus on specific dimensions of AA (e.g., cognitive vs. behavioral). For researchers interested in particular medical tests or treatments, the generic AA-Med scale also might be adapted or supplemented with additional intervention-specific items. Ultimately, we believe that further efforts to refine the measurement of individual differences in AA will shed light not only on its prevalence in particular populations, but on its determinants, outcomes, and implications for health communication efforts.

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References

Armstrong K, Weiner J, Weber B, Asch DA. Early adoption of BRCA1/2 testing: Who and why. Genetics in Medicine. 2003; 5(2):92–98. [PubMed: 12644778]

Briss P, Rimer B, Reilley B, Coates RC, Lee NC, Mullen P, et al. Promoting informed decisions about cancer screening in communities and healthcare systems. American Journal of Preventive Medicine. 2004; 26(1):67–80. [PubMed: 14700715]

Brouwers MC, Sorrentino RM. Uncertainty orientation and protection motivation theory: The role of individual differences in health compliance. Journal of Personality and Social Psychology. 1993; 65(1):102–112.

Budner S. Intolerance of ambiguity as a personality variable. Journal of Personality. 1962; 30:29–59. [PubMed: 13874381]

Buhr K, Dugas M. Intolerance for uncertainty scale: Psychometric properties of the English version. Behaviour Research and Therapy. 2002; 40:931–946. [PubMed: 12186356]

Camerer C, Weber M. Recent developments in modeling preferences Uncertainty and ambiguity. Journal of Risk and Uncertainty. 1992; 5:325–370.

Carney PA, Elmore JG, Abraham LA, Gerrity MS, Hendrick RE, Taplin SH, et al. Radiologist uncertainty and the interpretation of screening. Medical Decision Making. 2004; 24(3):255–264. [PubMed: 15155014]

Curley SP, Yates JF. An empirical evaluation of descriptive models of ambiguity reactions in choice situations. Journal of Mathematical Psychology. 1989; 33:397–427.

Einhorn HJ, Hogarth RM. Decision making under ambiguity. Journal of Business. 1986; 59(4):S225–S250.

Ellsberg D. Risk, ambiguity, and the Savage axioms. Quarterly Journal of Economics. 1961; 75:643–669.

Fridinger F, Macera C, Cordell HK. The use of surveillance data and market research to promote physical activity. American Journal of Preventive Medicine. 2002; 23(Suppl 2):56–63. [PubMed: 12133738]

Furnham A, Ribchester T. Tolerance of ambiguity: A review of the concept, its measurement and applications. Current Psychology. 1995; 14(3):179–199.

Geller G, Tambor ES, Chase GA, Holtzman NA. Measuring physicians' tolerance for ambiguity and its relationship to their reported practices regarding genetic testing. Medical Care. 1993; 31(11): 989–1001. [PubMed: 8231339]

Gerrity MS, DeVellis RF, Earp JA. Physicians' reactions to uncertainty in patient care. A new measure and new insights. Medical Care. 1990; 28(8):724–736. [PubMed: 2385142]

Goldsmith RE, Goldsmith EB. An empirical study of overlap of innovativeness. Psychological Reports. 1996; 79:1113–1114.

Goldsmith RE, Hofacker CF. Measuring consumer innovativeness. Journal of the Academy of Marketing Science. 1991; 19:209–221.

Greco V, Roger D. Coping with uncertainty: The construction and validation of a new measure. Personality and Individual Differences. 2001; 31:519–534.

Groeneveld PW, Sonnad SS, Lee AK, Asch DA, Shea JE. Racial differences in attitudes toward innovative medical technology. Journal of General Internal Medicine. 2006; 21:559–563. [PubMed: 16808736]

Gust DA, Kennedy A, Shui I, Smith PJ, Nowak G, Pickering LK. Parent attitudes toward immunizations and healthcare providers the role of information. American Journal of Preventive Medicine. 2005; 29(2):105–112. [PubMed: 16005806]

Han PK, Moser RP, Klein WM. Perceived ambiguity about cancer prevention recommendations: Relationship to perceptions of cancer preventability, risk, and worry. Journal of Health Communication. 2006; 11(Suppl 1):51–69. [PubMed: 16641074]

Han PK, Moser RP, Klein WM. Perceived ambiguity about cancer prevention recommendations: Associations with cancer-related perceptions and behaviours in a US population survey. Health Expectations. 2007; 10(4):321–336. [PubMed: 17986069]

Han PKJ, Kobrin SC, Klein WMP, Davis WW, Stefanek ME, Taplin SH. Perceived ambiguity about screening mammography recommendations: Association with future mammography uptake and perceptions. Cancer Epidemiology, Biomarkers, and Prevention. 2007; 16(3):458–456.

Han PKJ, Moser RP, Klein WMP, Beckjord EB, Dunlavy AC, Hesse BW. Predictors of perceived ambiguity about cancer prevention recommendations: Sociodemographic factors and mass media exposures. Health Communication. (in press).

Jepson RG, Forbes CA, Sowden AJ, Lewis RA. Increasing informed uptake and non-uptake of screening: Evidence from a systematic review. Health Expectations. 2001; 4(2):116–126. [PubMed: 11359542]

Kahn BE, Sarin RK. Modeling ambiguity in decisions under uncertainty. Journal of Consumer Research. 1988; 15(2):265–272.

Kreuter MW, Holt CL, Skinner CS. Awareness of mammography controversy among lower-income African American women in urban public health centers. Journal of Womens Health (Larchmt). 2004; 13(1):121–122.

Kruglanski AW, Webster DM. Motivated closing of the mind: “Seizing” and “freezing”. Psychological Review. 1996; 103(2):263–283. [PubMed: 8637961]

Kuhn KM. Communicating uncertainty: Framing effects on responses to vague probabilities. Organizational Behavior and Human Decision Process. 1997; 71(1):55–83.

Kuhn KM, Budescu DV. The relative importance of probabilities, outcomes, and vagueness in hazard risk decisions. Organizational Behavior and Human Decision Process. 1996; 68(3):301–317.

Maibach EW, Maxfield A, Ladin K, Slater M. Translating health psychology into effective health communication: The American Healthstyles audience segmentation project. Journal of Health Psychology. 1996; 1(3):261–277. [PubMed: 22011991]

Maibach EW, Weber D, Massett H, Hancock GR, Price S. Understanding consumers’ health information preferences: Development and validation of a brief screening instrument. Journal of Health Communication. 2006; 11(8):717–736. [PubMed: 17190779]

Meszaros JR, Asch DA, Baron J, Hershey JC, Kunreuther H, Schwartz-Buzaglo J. Cognitive processes and the decisions of some parents to forego pertussis vaccination for their children. Journal of Clinical Epidemiology. 1996; 49(6):697–703. [PubMed: 8656233]

Miller SM. Monitoring and blunting: Validation of a questionnaire to assess styles of information seeking under threat. Journal of Personality and Social Psychology. 1987; 52(2):345–353. [PubMed: 3559895]

Mishel MH. The measurement of uncertainty in illness. Nursing Research. 1981; 30(5):258–263. [PubMed: 6912987]

Mishel MH. Adjusting the fit: Development of uncertainty scales for specific clinical populations. Western Journal of Nursing Research. 1983; 5(4):355–370. [PubMed: 6559492]

Nelson DE, Gallogly M, Pederson LL, Barry M, McGoldrick D, Maibach EW. Use of consumer survey data to target cessation messages to smokers through mass media. American Journal of Public Health. 2008; 98(3):536–542. [PubMed: 17600264]

O’Neill SC, DeMarco T, Peshkin BN, Rogers S, Rispoli J, Brown K, et al. Tolerance for uncertainty and perceived risk among women receiving uninformative BRCA1/2 test results. American Journal of Medical Genetics, Part C, Seminars in Medical Genetics. 2006; 142C(4):251–259.

Politi MC, Han PK, Col NF. Communicating the uncertainty of harms and benefits of medical interventions. Medical Decision Making. 2007; 27(5):681–695. [PubMed: 17873256]

Pollard, WE. Use of consumer panel survey data for public health communication planning: An evaluation of survey results. Annual Meeting of the American Statistical Association, Joint Statistical Meetings; New York, NY. 2002.

Porter-Novelli. ConsumerStyles and HealthStyles 2007. Internal communication. 2008.

Raffle A. Information about screening—is it to achieve high uptake or to ensure informed choice? Health Expectations. 2001; 4(2):92–98. [PubMed: 11359539]

Ritov I, Baron J. Reluctance to vaccinate: Omission bias and ambiguity. Journal of Behavioral Decision Making. 1990; 3:263–277.

Scientific Advisory Committee of the Medical Outcomes Trust. Assessing health status and quality-of-life instruments: Attributes and review criteria. Quality of Life Research. 2002; 11:193–205. [PubMed: 12074258]

Smithson M. Conflict aversion: Preference for ambiguity vs conflict in sources and evidence. Organizational Behavior and Human Decision Process. 1999; 79(3):179–198.

Sorrentino, RM.; Roney, CJR. The uncertain mind: Individual differences in facing the unknown. Philadelphia: Taylor & Francis; 2000.

Viscusi WK, Magat WA, Huber J. Smoking status and public responses to ambiguous scientific risk evidence. Southern Economic Journal. 1999; 66(2):250–270.

Table 1

Distribution of sociodemographic characteristics of survey respondents (HealthStyles 2007)

	*N**	Weighted %†
Age		
<30	284	18.7
30–39	830	20.7
40–49	1057	19.0
50–59	1018	18.9
60–69	638	12.3
≥70	571	10.4
Sex		
Male	2014	48.4
Female	2384	51.6
Race		
White	2994	68.7
Black	556	11.8
Other	848	19.5
Education level		
Less than high school	258	5.9
High school graduate	1143	26.0
Some college	1580	35.9
College graduate	1360	30.9
Income level		
Under $15 K	643	14.6
$15 K–$24.9 K	541	12.3
$25 K–$39.9 K	730	16.6
$40 K–$59.9 K	780	17.7
≥$60 K	1847	38.8

* Raw frequencies; total sample $N = 4,398$ (decreased and unequal n for individual variables due to missing data).

† Percentages weighted to the 2006 U.S. Census.

Table 2

Distribution of responses to vignettes regarding interest in an ambiguous colon cancer screening test (HealthStyles 2007)

	N[*]	Weighted %[†]	*z*	*p*
Vignette 1: Missing information			28.187	<**.001**
Very willing	679	14.6		
Somewhat willing	2203	50.3		
Somewhat unwilling	907	21.8		
Very unwilling	544	13.2		
Vignette 2: Conflicting information				
Very willing	342	7.1		
Somewhat willing	1732	39.3		
Somewhat unwilling	1562	36.5		
Very unwilling	691	17.1		

[*] Raw frequencies; total sample $N = 4{,}398$ (decreased and unequal n for individual variables due to missing data).

[†] Percentages weighted to the 2006 U.S. Census.

Table 3

Univariate associations between ambiguity aversion (AA) and interest in an ambiguous colon cancer screening test (HealthStyles 2007)

	N[*]	AA score[†]	S.E	df	*F*	*p*
Vignette 1: Missing information				3, 4170	61.290	<**.001**
Very willing	619	2.741	0.033			
Somewhat willing	2122	2.992	0.018			
Somewhat unwilling	916	3.230	0.025			
Very unwilling	551	3.391	0.058			
Vignette 2: Conflicting information				3, 4168	42.801	<**.001**
Very willing	297	2.807	0.049			
Somewhat willing	1660	2.912	0.020			
Somewhat unwilling	1538	3.120	0.020			
Very unwilling	711	3.380	0.048			

[*] Raw frequencies; total sample $N = 4{,}398$ (decreased and unequal n for individual variables due to missing data).

[†] Range 1–5.

Table 4

Multivariate regression analyses predicting interest in an ambiguous colon cancer screening test (HealthStyles 2007)

Step	ΔR^2	ΔF	*P*	Predictor variables	β	*p*
Vignette 1: Missing information *						
1	.036	15.658	<.001	Sociodemographic †		
2	.073	337.963	<.001	Ambiguity aversion	−.362	<.001
Vignette 2: Conflicting information *						
1	.014	6.025	<.001	Sociodemographic †		
2	.067	300.589	<.001	Ambiguity aversion	−.331	<.001

* Model $N = 4,287$ due to missing data.

† Age, sex, race, education, income.

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Table 5

Univariate associations between ambiguity aversion (AA) and sociodemographic and health-related characteristics (HealthStyles 2007)

	Weighted *N*[*]	High AA *N* (%)[†]	AA score (*M*)[‡]	S.E	df	*F*	*p*
Age					5, 4230	7.932	<**.001**
<30	819	123 (15.0)	3.150	0.054			
30–39	884	78 (8.8)	3.048	0.026			
40–49	813	55 (6.8)	2.974	0.021			
50–59	797	69 (8.7)	2.990	0.022			
60–69	518	66 (12.7)	3.089	0.031			
≥70	421	68 (16.2)	3.182	0.034			
Sex					1, 4224	9.824	**.002**
Male	2065	193 (9.4)	3.015	0.020			
Female	2186	268 (12.3)	3.104	0.020			
Race					1, 4224	12.314	<**.001**
White	2929	275 (9.4)	3.027	0.017			
Black/Other	1322	186 (14.1)	3.135	0.026			
Education level					3, 4180	18.601	<**.001**
Less than high school	236	47 (19.9)	3.293	0.070			
High school graduate	1097	146 (13.3)	3.176	0.029			
Some college	1537	147 (9.6)	3.056	0.023			
College graduate	1329	114 (8.6)	2.931	0.024			
Income level					4, 4221	8.191	<**.001**
Under $15 K	608	95 (15.6)	3.154	0.046			
$15 K–$24.9 K	521	88 (16.9)	3.224	0.049			
$25 K–$39.9 K	706	65 (9.2)	3.057	0.034			
$40 K–$59.9 K	756	86 (11.4)	3.064	0.034			
≥$60 K	1660	128 (7.7)	2.976	0.019			

[*] Weighted to the 2006 U.S. Census, total sample $N = 4{,}398$ (decreased and unequal n for individual variables due to missing data).

[†] High AA defined as scale scores ≥4 on the 5-point scale.

[‡] Range 1–5.

Appendix 1

Ambiguity Aversion scale items

COG1: If experts had conflicting opinions about a medical test or treatment, it wouldn't be worth trying.
COG2: Conflicting expert opinions about a medical test or treatment would lower my trust in the experts.
COG3: I would not have confidence in a medical test or treatment if experts had conflicting opinions about it.
AFF1: Conflicting expert opinions about a medical test or treatment would make me upset.
AFF2: Conflicting expert opinions about a medical test or treatment would make me feel more worried about my own health.
AFF3: I would not be afraid of trying a medical test or treatment even if experts had conflicting opinions about it.[1]
BEH1: If experts had conflicting opinions about a medical test or treatment, I would still be willing to try it.[1]
BEH2: If experts had conflicting opinions about a medical test or treatment, I would try to learn as much as possible about the issues.
BEH3: If experts had conflicting opinions about a medical test or treatment, I would let my doctor decide about whether I should have it.
BEH4: I would avoid making a decision about a medical test or treatment if experts had conflicting opinions about it.

Bolded items were retained in final 6-item scale.

COG – cognitive, AFF – affective, BEH – behavioral items.

Five-point numeric response scale for all items, with end points labeled "strongly disagree" and "strongly agree."

[1]Reverse-scored item.

Appendix 2

Personal Innovativeness scale (Armstrong et al., 2003)

If I heard of a new medical test or treatment, I would try to find out more about it.
Among my friends, I am usually one of the first to find out about a new medical test or treatment.
In general, I am hesitant to undergo a new medical test or treatment.

Five-point numeric response scale for all items, with end points labeled “strongly disagree” and “strongly agree.”

Appendix 3

Hypothetical vignettes: Ambiguous colon cancer screening test (HealthStyles 2007)

For the next two questions, imagine that your doctor wants you to be checked for colon cancer. There are several tests to choose from, including a brand new test. Your doctor wants you to decide which test to have, because there is some controversy about the new test.

1. Consider the following scenario [Missing information]:

Scenario A: Studies have shown that the new colon cancer test is better than the other tests at telling whether or not someone has colon cancer, but only a few small studies have been done so far. More studies are being done, but the results are not in yet.

How willing would you be to have the new colon cancer test right now?

2. Now consider a slightly different scenario [Conflicting information]:

Scenario B: Several studies of the new colon cancer test have been done, but the studies give different results: some studies show that the new test is better than the other tests at telling whether or not someone has colon cancer. However, other studies show that it is not as good as the other tests. Therefore, some medical experts recommend the test, while others don't.

How willing would you be to have the new colon cancer test right now?

[1] Four-point response scale for all items: "very unwilling," "somewhat unwilling," "somewhat willing." "very willing."