

PERSUASION TOWARDS GENETIC TESTING
AS A HEALTH OUTCOME

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Submitted in partial fulfillment of the
requirements for Departmental Honors in
the Department of Communication Studies
Texas Christian University
Fort Worth, Texas

May 4, 2015

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AS A HEALTH OUTCOME

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ABSTRACT

The study examined the effect of risk and uncertainty in the form of penetrance on interest in genetic testing, among other variables. Health providers may benefit from knowing what levels of these salient variables produce highest interest or motivate an individual to seek the intervention of genetic testing or change other health behaviors. The study used 2 x 2 between subjects design with four conditions: (1) Low risk, low penetrance, (2) low risk, high penetrance, (3) high risk, low penetrance, and finally (4) high risk, high penetrance. Texas Christian University students enrolled in communication classes (N=90) were randomly assigned to one of the four conditions. A TCU student news article was used to manipulate both risk and penetrance. Higher levels of penetrance lead to increases in behavioral intentions, interest, and attitude about genetic testing. Findings suggest that efficacy, with risk and penetrance plays a role in the perception of severity. Together, risk, penetrance, and efficacy interact to construct four groups of individuals: *Indifference*, *Denial*, and two distinct *Rationality* groups. Use of these rationale behind these groups may inform providers on how to better persuade patients to engage in preventative measures such as genetic testing.

ACKNOWLEDGEMENTS

I would like to thank Dr. Adam Richards for his unimaginable patience and mentorship for the duration of this project. This entire process would have been impossible without his expertise and inventiveness. I'm also gracious for my committee members Dr. Paul Witt and Dr. Matt Chumchal for all their help and input. A big thank you to the TCU Communication Studies department and students for their participation and assistance getting this thesis finished. Lastly, thanks to my family and all the friends to whom I've expressed my passion about these topics and this project over and over again. Your open and listening ears are so, so appreciated.

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INTRODUCTION

The past decade has opened up major doors in the science research community concerning the role of genetics in human health. With the completion of the Human Genome Project in 2003, scientists were able to read the entire human genetic blueprint for the first time. Other advances have led to the establishment of links between genes and the presence or development of a disease. Despite the increasing relevance and major advances in the field of genomics, health communication efforts involving genetics have lagged behind the science (Parrott et al., 2012). The need continually grows for health care professionals and providers who possess the ability to communicate effectively about these topics. With communicative behaviors in health-related circumstances becoming a progressively essential field of study, this study aims to pinpoint the emerging and evolving topic of genetic information. Health providers must know more about the effect of salient communication variables on behaviors like health information seeking within the realm of genetics and genetic testing. Using the current health communication literature about predictors of health information-seeking behaviors, the goal of this study is to provide a sort of prescription for health providers with message-based recommendations for optimal levels of salient variables that lead to the choice (or high interest in) to take a genetic test.

Communication of Genetic Risk

Risk and its perception is one of the most well studied variables in health communication. Standard practices for genetic counseling and testing rely heavily on risk communication to convey information about personal risk (Croyle et al., 1999). For example, pretest information often focuses on individual risk status, including the

likelihood that the individual has or will inherit a cancer or disease-predisposing gene or genetic mutation (Botkin et al., 1997; Peters et al., 1996). Studies have also shown that the perception of risk plays an important role in how individuals think and disclose information about genetics and genetic testing (Ashida et al., 2009). Furthermore, this perceived risk has been shown to correlate with genetic testing intentions (Struewing et al., 1995; Bluman et al., 1999; Lerman et al., 1994)

Research has indicated that risk can push individuals in both directions: towards genetic testing and health information seeking, but also away from proactive behaviors (Parrott et al., 2012). Individuals with high self-efficacy that feel able to handle the consequences of the test may be more motivated by risk. Individuals may also be motivated by high risk under conditions of reduced uncertainty (Han et al., 2009). These same variables can also keep an individual from being motivated by risk when uncertainty is too high or efficacy is low. Many other factors such as worry, anxiety, and control have also been associated with affecting risk as a motivator or deterrent of information seeking behaviors (Rosen et al., 2009; Ashida et al., 2009; Shiloh et al., 1999). Either way, it is clear that comprehension of risk is critical making the decision about whether to have a genetic test.

Uncertainty & Penetrance

Studies have indicated management of uncertainty as a salient factor in determining health information seeking behaviors. However, results are inconclusive on the effect of uncertainty as either a motivator or a deterrent of information seeking (Brashers, 2001; Barbour et al., 2012). For example, perceptions of uncertainty surrounding cancer

prevention and screening have been associated with both lower efficacy perceptions and diminished uptake of these interventions (Han, Moser, & Klein, 2007; Han et al., 2007). Uncertainty also acted as significant negative predictor of interest in the hypothetical colon cancer screening (Han et al., 2009).

Conversely, uncertainty has also been indicated as a motivator under certain trait conditions, such as the characteristic of being a high monitor. Outside of this condition, however, lower levels of uncertainty lead to a greater interest in seeking health information (Shiloh et al., 1999). Rosen et al. (2009) also found that certain sources of uncertainty, i.e. situational uncertainty, are motivators of health information seeking. Overall, these contradictory findings suggest the need for further research on uncertainty and its role in health contexts, especially involving genetics.

This study focuses on uncertainty inherent to communication about genetic testing, specifically the concept of penetrance. Penetrance, the percentage of people with the gene or genetic mutation that develop the disease, presents a unique and unstudied form of uncertainty characteristic of genetics. This source of uncertainty sits within the gene or genetic mutation itself; that is, penetrance is intrinsic. While a gene and disease may be linked causally, or just simply correlated, there is always a certain penetrance associated. Biologically speaking, however, genes constantly interact with the environment and other genes to have a composite effect on different aspects of health such as disease development. This fact opens the door for strategic messages that may manipulate the way in which individuals perceive penetrance, a factor that may very well influence health behaviors and decisions as a new source of uncertainty.

Risk Perception Attitude Framework

There is a great deal of literature concerning the separate connections between health information seeking behaviors and the variables of risk, efficacy, and uncertainty. The Risk Perception Attitude (RPA) framework (Rimal & Real, 2003) posits that both risk and self-efficacy predict information-seeking behaviors, and, when considered together, characterize four groups that seek information differently. The first group, those with high risk and high self-efficacy tend to seek information most readily, taking a *responsive* approach to deal with the risk. Those characterized by the *avoidance* attitude also perceive high risk, but with low self-efficacy. This leads to a desire to deal with the risk, but this motivation conflicts with the fact that they don't feel able to do so. The third group has a *proactive* approach to dealing with their low risk perception, due to their high self-efficacy beliefs. It is these beliefs that allow them to pursue information regarding their health. Lastly, the *indifferent* group is characterized by having both low risk, as well as low self-efficacy. In this instance, there is the least motivation to seek information (Rimal & Real, 2003). This study seeks to extend the RPA to the context of genetic testing by incorporating risk and uncertainty in the form of penetrance.

Implications of RPA and Uncertainty on Genetic Testing

Conceptually, genetic testing poses the challenging issues that individuals face when deciding whether to seek information under varying conditions of uncertainty and risk. Genomics presents the perfect information seeking research problem (Johnson et al., 2005) as it consistently questions conventional opinions on individuals' motivation to seek information. The critical tug-of-war individual's feel between managing their risk and their uncertainty is what makes genetic testing such a difficult choice at its core

(Afifi et al., 2009). Studies are beginning to suggest situational features of genetic testing that challenge the management of uncertainty. These situational aspects include risk and even efficacy, which also been established as a central feature of uncertainty management (Afifi & Weiner, 2004). More so than on their own, RPA and uncertainty work best together to explain nuances in information seeking and intentional health behaviors such as getting a genetic test.

Formulation of Hypotheses

This study assessed the effect of two health-information variables related to interest in a getting a genetic test related to disease symptoms: (1) perceived risk of disease and (2) uncertainty surrounding the penetrance of the gene or the proportion of individuals with the gene that manifest the associated trait or phenotype. The overall purpose of this research is to assess the how combinations of these variables predict interest of a genetic test. These variables have been studied in different combinations, but never in this way in the context of genetics and genetic testing. Additionally, the variables are well suited to test in the context of genetic information seeking, as genetic tests possess certain degrees of uncertainty regarding the extent to which having a gene affects health outcomes in the future.

At different levels of perceived risk, I predict uncertainty will be an important variable in predicting information seeking behaviors because of its well studied, yet intricate role in behavioral responses. In combination with risk and possibly efficacy as predicted by RPA, uncertainty as functionalized by level of penetrance may take on a new and complex function in predicting information-seeking behaviors regarding health.

H1: High penetrance (low uncertainty), when paired with high risk, will elicit responsive behavior and strongest interest in genetic testing.

H2: Those in the condition of both low risk and low penetrance will demonstrate the least interest in the intervention.

H3: Moderate interest will be displayed when risk is high, but penetrance is low, and vice versa. RPA implications lend themselves to predictions of efficacy as a moderator of the relationship between risk and penetrance in these conditions, such that interest in testing will be greatest when efficacy is high, rather than low.

METHOD

Participants

Participants were recruited through Texas Christian University Communication Studies classes. No students under the age of eighteen were recruited and participation was completely voluntary and participants could withdrawal from the study at any time. Students were offered either minimal course credit (approximately 2%) or extra credit (approximately 2%) for completing the questionnaire. Students who elected not to participate had the option to complete an alternative assignment for equal credit. The alternative assignment, roughly equivalent in time, gave students the opportunity to earn course credit or extra credit points without participating in the study. The participant sample included 27 men and 64 women with a mean age of 20.08 (SD=2.76, range of 18-38 years). A majority of participants identified as Caucasian/White (86.8%), with the remaining percentage comprised of those who identified as Hispanic, African American,

Asian/Island Pacific, or other. Overall sample means for each scale can be seen in Table 1.

Procedure

I sought to uncover relationships between variables through an experimental design that (a) experimentally manipulated my independent variables (low/high risk and low/high penetrance), and also utilized (b) random assignment to experimental conditions to level out peripheral effects. This gave way to a 2 x 2 between subjects design with four conditions: (1) Low risk, low penetrance, (2) low risk, high penetrance, (3) high risk, low penetrance, and finally (4) high risk, high penetrance. After obtaining instructor permission, participants completed an online consent form and then moved on to an online questionnaire using Qualtrics software. All responses were completely anonymous as students entered in an identification number, but were not matched with their responses. Some students had the opportunity to complete the questionnaire during or outside of a class lab session, as is common for research participation through the communication studies public speaking course or other similar courses.

Students who gave their consent to participate were randomly assigned to an experimental condition in which risk and penetrance were manipulated in the form of a fictitious TCU 360 student news article. The manipulations messages included fictitious new research on a fictitious gene and immune disease, created for the purposes of this experiment. Such slight deception is necessary to control the experimental conditions in such a way to yield accurate measurements of how those under similar conditions would actually feel and respond. Similar types of procedures are common in studies involving manipulation of uncertainty, controllability, and information seeking in disease (Rosen et

al., 2009; Meyerowitz et al., 1987), as well as in studies on patient decision-making (Freymuth & Ronan, 2004). Additionally, using a fictitious gene and disease prevents participants' previous knowledge of a real disease or gene of interfering with manipulations or results.

Manipulation of Risk

Individuals were induced to perceive high or low genetic risk through the article manipulation. Those individuals assigned to the high-risk condition read that “over 90% of college students have the XAd gene,” (the fictitious gene) as well as “this is an unusually high prevalence for a gene.” Participants in the low risk conditions received the parallel message that “under 10% of college students have the XAd gene,” and that “this is an unusually low prevalence for a gene.” These specific messages were accompanied by other risk manipulations throughout the article. Each condition was specifically designed to make the participant feel as if they are very susceptible, or only slightly at risk for having the XAd gene. (See Appendix A for article manipulations).

Manipulation of Penetrance

Penetrance was manipulated to induce a strong or weak (high or low) causal relationship between the XAd gene and the fictitious Continuously Compromised Immunodeficiency Disease, or CCI disease. Participants assigned to the highly penetrant condition received the message that this new gene was “found to cause” CCI. On the other hand, those in the low penetrance condition read that this gene simply was “found to be linked to” the immune disease. Manipulations of penetrance continued throughout the article, informing those in the high penetrance condition that they are “guaranteed” to develop CCI “with certainty.” Low penetrance participants read nearly the same message, except they were

only “slightly more likely” to develop the disease. Participants in the high penetrance condition were provided manipulations of penetrance with the intent of reducing feelings of uncertainty about the gene’s connection to the disease. Those participants in the low penetrance condition, however, were intended to experience stronger feelings of uncertainty regarding the connection between the gene and the disease.

After reading the message, participants then completed the questionnaire by answering items that measured their interest in getting the genetic test, their desire to learn more about what they have just read, as well as completing items that ensured successful manipulations of the independent variables. Participants then read a debriefing statement informing them of the purpose of the study and the fictitiousness of the gene and disease.

Measures

Self-Efficacy of Management. The participants perceived individual ability to manage the disease and its symptoms was measured with 6 items: 3 items on a 1 (not at all confident) to 7 (extremely confident) scale and 3 items on a 1 (strongly disagree) to 7 (strongly agree) scale. Examples include “How confident do you feel in your ability to manage the symptoms of CCI disease if you were to develop it?” and “I would be able to lessen the physical symptoms of CCI disease if I developed it.” Items were pooled to give a Cronbach’s alpha of .95.

Response Efficacy. To improve the validity of my conclusions, I also included a measure of response efficacy. Participants were measured on their beliefs on the options available to handle the disease with 3 items on a scale from 1 (strongly disagree) to 7 (strongly agree). Items posited statements like “There are many options available to help manage the symptoms of CCI disease if I were to develop it.” Cronbach’s alpha was .88.

Severity. Perceived severity, or how serious the participants believed the disease and risks associated with the disease to be, was measured with 10 items on a 1 (strongly disagree) to 7 (strongly agree) scale. Examples include “I believe that the risks associated with CCI disease are a severe threat to me.” and “I believe that CCI disease can have serious negative consequences.” Cronbach’s alpha was .82.

Behavioral Intentions. Intentions to get a genetic test for the XAd gene were measured as participants were asked to indicate how likely or unlikely each of the following items would be if a genetic test was made readily available to you and was free of charge. Behavioral intentions were measured with 3 items on a 1 (extremely unlikely) to 5 (extremely likely) scale and gave a Cronbach’s alpha of .91. Participants were asked questions like “How likely would you be to take test that could tell you whether you had the XAd gene?”

Interest. Overall interest in learning more about the genetic test and the disease was also measured for increased validity. Participants completed 11 items that asked them on a 1 (definitely not) to 5 (definitely yes) scale if they were interested in, for example, “receiving more written information about the genetic test for XAd?” or “receiving a pamphlet on the details of CCI disease?” Cronbach’s alpha was 0.95.

Attitude. To assess attitude towards getting a genetic test, participants were asked to rate 5 items on a 1 to 10 scale how they felt about getting a genetic test. Higher scores reflect a more positive attitude, such as good, wise, or beneficial in contrast to bad, foolish, or harmful. Cronbach’s alpha was .88.

Health Locus of Control. Previous research (Croyle et al., 1999; Patel, 2013) indicates that locus of control plays an important role in health information seeking and

specifically genetic testing. Therefore, participants completed 6 items on a 1 (strongly disagree) to 7 (strongly agree) scale, specifically measuring the degree to which they felt their health was in their control. Examples include “If I become sick, I have the power to make myself well again” and “My physical well-being depends on how well I take care of myself.”

Manipulation checks. To make sure the article truly induced changes in perceived risk and penetrance, manipulation checks were completed in a similar way to the above measures.

Penetrance

Perceived penetrance was measured with 3 items on a 1 (strongly disagree) to 7 (strongly agree) scale, resulting in a Cronbach’s alpha of .73. Examples include “A person with a positive test result for the XAd gene is more likely to develop CCI disease” and “Someone who is a carrier of the XAd gene has an increased chance of developing CCI disease.”

Risk

To assess the risk manipulation, participants were asked to complete 2 items with a Cronbach’s alpha of .85. The 2 items asked the participants to adjust a sliding percentage (0-100%) scale to indicate “How likely is it that you have the XAd gene?” and “What is the percentage of people who are affected by the XAd gene?”

RESULTS

Manipulation Checks

Two manipulation checks were done, one for risk perception and one for penetrance. Two-way factorial analysis of variance (ANOVA) of participants’ evaluations of risk

showed a significant main effect, $F(1, 87)=130.68$, $p < .000$, with those in the high risk conditions reporting greater perceived risk on a 100-point scale ($M = 64.31$, $SD = 25.54$) than those in the low risk condition ($M = 16.06$, $SD = 13.48$). Similarly, ANOVA on perceived penetrance showed a significant main effect, $F(1, 87)=3.348$, $p = .035$, with those in the high penetrance conditions reporting greater perceived penetrance on a 7-point scale ($M = 5.85$, $SD = 1.17$) than did those in the low penetrance conditions ($M = 5.41$, $SD = 1.01$). Significant differences in the high and low conditions of the variables indicate successful manipulations of both risk and penetrance.

Main Analysis

Means, standard deviations, and sample sizes for measured variables are reported by condition in Table 2. Analyses were conducted using two-way ANCOVAs with risk and penetrance, as well as reported response efficacy and its interactions with the experimental variables, entered as independent variables.

Main Effects of Penetrance

A significant main effect for penetrance was found on behavioral intentions (BI), interest (INT) and attitude (ATT) (Table 3). Participants in the high penetrance condition showed significantly greater behavioral intentions to get a genetic test ($M = 3.56$) than those at low penetrance ($M = 3.26$). Similarly, individuals at high penetrance also felt significantly more interested in finding out more about the genetic test and the disease ($M = 2.99$) than those in the low penetrance condition ($M = 2.59$). Lastly, the same positive relationship was seen between penetrance and attitude as those in the high penetrance condition displayed significantly more positive attitudes ($M = 7.34$) than participants in

the low penetrance condition ($M = 6.80$). No other significant main effects were found for penetrance or risk on any measured variables.

Interaction Effects

A significant two-way interaction, $F(1, 82)=6.05$, $p=.016$, was found between risk and penetrance on the measured variable of severity. At levels of low risk, severity relates positively with penetrance such that the higher the penetrance, the higher the perceived severity (Fig. 1). There is also a positive relationship between risk and severity, such that high risk predicts high severity, regardless of the level of penetrance. Notably, over 5% of variance in severity is predicted by this 3-way interaction ($\eta_p^2 = 0.052$).

A significant three-way interaction was found between risk, penetrance, and efficacy on the perception of severity, $F(1, 82)=4.50$, $p=.037$ (Fig. 2). With low response efficacy as a covariate, efficacy Risk is indicative of severity only when penetrance is low. At high levels of penetrance, risk and severity share an inverse relationship with response efficacy as a covariate. Therefore, response efficacy embellishes the perception of severity in conditions of low risk as seen in the two-way interaction; however, it does not in conditions of high risk.

DISCUSSION

Assessment of Hypotheses

Although analysis did not support my hypotheses as a whole, penetrance was found to positively predict behavioral intentions to get a genetic test, increase interest in the genetic test and the disease, as well as induce significantly more positive attitude about genetic testing as generally good, wise, and beneficial. While there were no other

significant main or interaction effects of the manipulated variables on interest in getting a genetic test, the participants' perceived severity was significantly affected.

Indifference, Denial, and Rationality: A nod to the RPA framework

The findings regarding severity give distinct groups that nicely mirror the four groups of the RPA (Fig.3). Specifically, under the condition of low response efficacy, four groups emerge that explain perceptions of severity in terms of risk and penetrance. In conditions of low risk and low penetrance, individuals perceive a low level of severity and are deemed *indifferent*. Due to the minimal risk and higher level of uncertainty, don't internalize the severity of the disease; consequently, these individuals may not feel inclined in either direction to seek the intervention. At levels of high perceived risk and penetrance, individuals perceive low levels of severity and are in *denial*. In conditions of denial, individuals feel as if the only option is avoiding the severity of the situation when faced with the fact that they are highly susceptible to having the gene that will definitely cause the disease. If there is nothing they can do about it (looking at levels low response efficacy), why acknowledge how severe it is or turn to an intervention strategy? The last two groups turn to *rationality* to cope with the competing factors of penetrance and risk. Both those participants who experience high risk and low penetrance, as well as low risk and high penetrance, perceive high levels of severity from a rational perspective. These individuals have the ability to acknowledge the severity of their situation due to the low level of either penetrance or risk, coupled with the high level of the other respective variable. Those who have a high likelihood of having the gene can realize a high level of severity because they feel this gene will probably not cause the disease. Alternatively,

those who do not feel as susceptible to the threat of having the gene still perceive the situation as severe due to the fact that if they do have the gene, they will get the disease.

Validity and Limitations

Internal validity is high due to rigorous study design and random assignment. While the sample population only consisted of those TCU students enrolled in communication classes at TCU, there was a range of ages, ethnicity, and sex that lends itself to generalizable results and high external validity. However, the sample may not be absolutely representative of the total population, somewhat limiting the generalizability of the findings to all populations at all times.

Certain limitations must be taken into account when discussing the results of the study. Firstly, a fictitious gene and disease were used to manipulate both risk and penetrance. While the manipulations were successful, believability of the messages as a whole was not measured. However, to increase external validity of the findings, the gene and disease were modeled after scientifically accurate relationships between genes, penetrance, and diseases like those associated with the immune system. Future research should focus on actual situations of differing risk and penetrance inherent in gene-disease relationships, such as those seen in Huntington's disease or breast cancer, to ensure that study results are generalizable to genuine health circumstances.

Implications and Future Research

At first glance, it may appear that emphasizing penetrance within health messages is the simple solution to persuading individuals to take a genetic test for genes that cause serious disease. After all, results show that higher penetrance significantly increases participants' behavioral intentions, overall interest, and attitudes towards the test.

However, the caveats of the study's findings and their interpretation lead to the need for a more informed and conscious use of strategic communication to persuade individuals to engage in the preventative measure of genetic testing. When interacting with risk and efficacy, it is important for health care professionals to acknowledge the differing effects of penetrance on the perception of severity and how this may affect the decision making process and information seeking behaviors. For example, providers need to be sure to prompt a higher perception of penetrance to someone in the indifferent category to increase their perception of severity, or increase the risk they feel to achieve the same effect. Messages that increase the perception of penetrance decreases the uncertainty the individual may feel. In some ways, this can be impractical as penetrance is inherent to a gene. In these cases, decreasing another source of uncertainty might help the individual rationalize and realize severity. In a similar way, convincing those in denial that the risk is either lower or that the penetrance of the gene is not as high may be needed to allow rationality and perception of severity. While severity is not equivalent to the measure of interest or intention to get a genetic test, multiple studies have associated severity with changes in health behaviors such as information seeking (Patel, 2013; Parrott et al., 2012; Rimal & Real, 2003; Brashers et al., 2002). Further research must be done to uncover the intricate relationship of severity's role in predicting interest in genetic testing when interacting with risk, penetrance, and efficacy.

Increased risk awareness, coupled with the continually advancing technology that allows us to detect disease with different degrees of uncertainty, profoundly impacts our health beliefs and behaviors. In order to educate both health care providers and patients on how to best adapt to this constantly evolving environment, communication scholars and

researchers alike must continue to elucidate the intricate web of factors that influence a variety of health outcomes, including that of genetic testing.

TABLES AND FIGURES

Table 1. Overall Sample Means for Measures

Measures	Scale	M	SD	N
PEN	1-7	5.67	1.12	91
RISK	1-100	35.15	30.42	91
SE	1-7	4.20	1.42	91
RE	1-7	4.70	1.24	91
SEV	1-7	3.88	.71	91
BI	1-7	3.41	1.08	90
INT	1-7	2.84	.98	90
ATT	1-10	7.10	2.04	90
HLC	1-7	4.88	.78	90

Note. Means (M) are listed with standard deviations (SD), sample sizes (N), along with the scale with which the measure was taken. PEN=penetrance; RISK=risk; SE=self-efficacy of management; RE=response efficacy; SEV=severity; BI=behavioral intentions; INT=interest; ATT=attitude; HLC= health locus of control

Table 2. Table of Means

Measures	Conditions							
	Risk		Penetrance		Risk x Penetrance			
	Low Risk	High Risk	Low Penetrance	High Penetrance	Low Risk, Low Penetrance	High Risk, High Penetrance	Low Risk, High Penetrance	High Risk, Low Penetrance
SE	4.30±1.38, 55	4.04±1.48, 36	4.19±1.28, 36	4.20±1.52, 55	4.15±1.44, 18	3.84±1.78, 18	4.37±1.37, 37	4.23±1.13, 18
RE	4.78±1.31, 55	4.58±1.14, 36	4.53±1.35, 36	4.82±1.17, 55	4.41±1.64, 18	4.52±1.29, 18	4.96±1.09, 37	4.65±1.01, 18
SEV	3.82±0.74, 55	3.98±0.66, 35	3.78±0.85, 36	3.95±0.60, 54	3.52±0.87, 18	3.92±0.54, 17	3.96±0.64, 37	4.03±0.77, 18
BI	3.42±1.13, 55	3.41±1.01, 35	3.19±1.21, 36	3.56±0.96, 54	2.96±1.31, 18	3.39±0.95, 17	3.64±0.97, 37	3.43±1.09, 18
INT	2.86±1.01, 55	2.90±0.93, 35	2.56±0.88, 36	3.02±1.00, 54	2.32±0.70, 18	2.99±0.88, 17	3.03±1.06, 37	2.80±0.99, 18
ATT	7.09±2.25, 55	7.11±1.69, 35	6.63±2.22, 36	7.41±1.87, 54	6.50±2.71, 18	7.47±1.70, 17	7.38±1.97, 37	6.77±1.66, 18
HLC	4.91±0.81, 55	4.83±0.75, 35	4.83±0.76, 36	4.91±0.80, 54	4.75±0.82, 18	4.75±0.80, 17	4.98±0.80, 37	4.91±0.72, 18

Note. Means are listed with standard deviations, then sample sizes. SE=self-efficacy of management; RE=response efficacy; SEV=severity; BI=behavioral intentions; INT=interest; ATT=attitude; HLC= health locus of control.

Table 3. Main Effects of Penetrance

Measures	Penetrance		<i>p</i>
	High Penetrance (M)	Low penetrance (M)	
BI	3.26	3.56	F(1, 82)=4.75, p=.032
INT	2.59	2.99	F(1, 82)=3.94, p=.025
ATT	6.80	7.34	F(1, 82)=8.025, p=.006

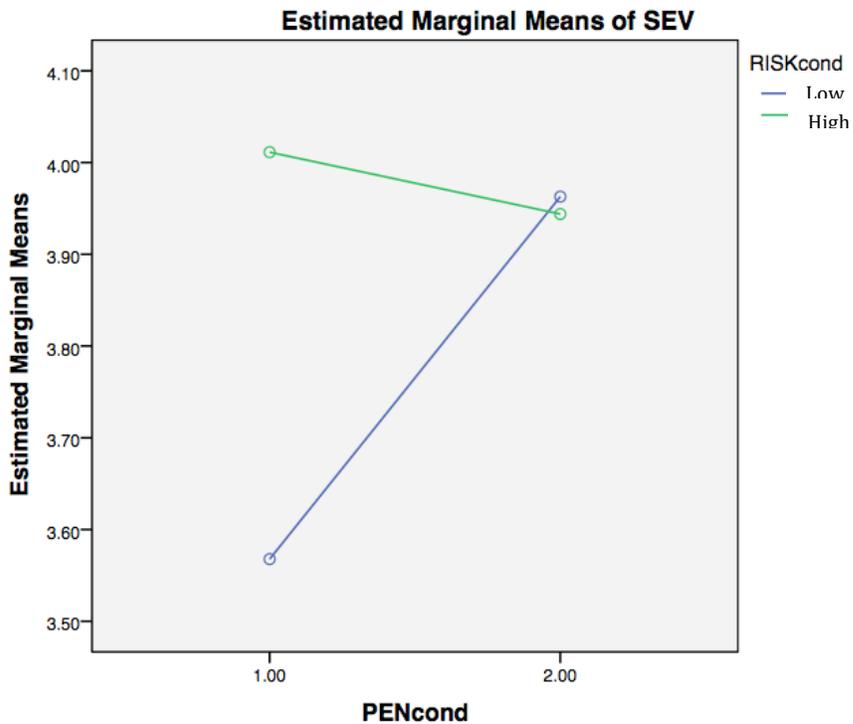


Figure 1. Significant two-way interaction of penetrance and risk on the measure of severity; $p=0.016$.

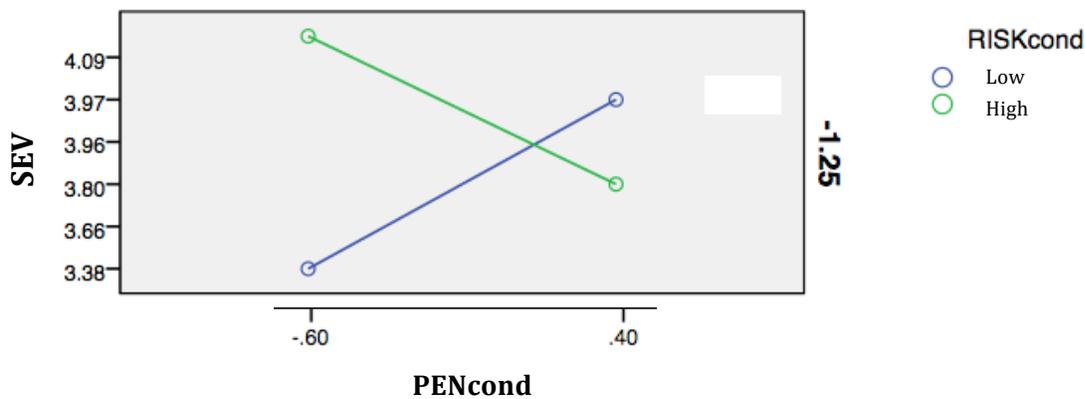


Figure 2. Significant three-way interaction of penetrance, risk, and response efficacy on the measure of severity; $p=0.037$.

		Risk	
		↑	↓
Penetrance	↓	LOW severity: INDIFFERENCE	HIGH severity: RATIONALITY due to low penetrance
	↑	HIGH severity: RATIONALITY due to low risk	LOW severity: DENIAL

Figure 3. Indifference, denial, and rationality groups as defined by levels of perceived severity due to interactions between penetrance and risk in conditions of low response efficacy.

APPENDIX A: ARTICLE MANIPULATIONS

Manipulation 1. High Penetrance (Uncertainty), High Susceptibility (Risk)

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News Stories / News / New gene linked to immune disease

New gene found to cause immune disease in college students

Over 90% of college students have the XAd gene, according to TCU alumnus

By [Tatum Walker](#) // Posted February 20, 2015 f 17 t 3 g+ 0

Is there a genetic reason some of us are getting sick and staying sick? For most of us, the answer is definitely yes. Fortunately, it is easy to manage symptoms of the disease if you have it.

Class of 1987 graduate Dr. Sidney Harvey may have the most concrete answer we've had in the last decade. Harvey and his research lab at Johns Hopkins University have recently uncovered a gene, XAd, which has been identified as the definite cause for the development of Continuously Compromised Immunodeficiency disease. CCI disease is a condition that can cause many infections in numerous college-aged patients. For those with the XAd gene, CCI disease is sure to follow.

“To be clear, having the gene is not directly linked to getting infections all the time. Rather, the gene is linked to developing CCI disease, which can *then* lead to you getting sick. **But there is a lot you can do to decrease the likelihood of getting sick if you have the disease.**” -Dr. Harvey

The disease, which is thought to be quite manageable for college students, can create serious health implications if gone unmanaged. People with CCI disease may catch a small respiratory infection that can very quickly move to pneumonia or other detrimental infections due to their compromised immune system. CCI disease can lead to problems with normal digestion, delayed growth and development, chronic inflammation, and even death from serious infection.

Those with the XAd gene are guaranteed to develop CCI disease. Taking a simple genetic test for the gene, like a blood or tissue sample, would tell you whether or not you will definitely develop CCI disease. A positive test result would indicate with certainty that you will develop CCI disease.

Dr. Harvey has also found that over 90% of college students presently carry the XAd gene. This is an unusually high prevalence for a gene in a population or community. This means that more than 9 out of every 10 people you see on campus have this gene that will cause CCI disease. Many patients with CCI disease find it easy to decrease the frequency of infections that come with the disease. Most people experiencing CCI disease feel that they are able to lessen the physical symptoms of the disease. While it is possible for the infections to produce complications, patients often feel able to tackle the negative issues that come with CCI disease.

As a college student, it is likely that you have the XAd gene, which guarantees the development of CCI disease.

While CCID is serious, there is much you can do. If you have the gene, it is easy to manage the onset and progression of the disease.

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Dr. Sidney Harvey, TCU alumnus

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New gene found to cause immune disease in college students

Under 10% of college students have the XAd gene, according to TCU alumnus

By [Tatum Walker](#) // Posted February 20, 2015

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The disease, which is thought to be quite manageable for college students, can create serious health implications if gone unmanaged. People with CCI disease may catch a small respiratory infection that can very quickly move to pneumonia or other detrimental infections due to their compromised immune system. CCI disease can lead to problems with normal digestion, delayed growth and development, chronic inflammation, and even death from serious infection.

Those with the XAd gene are guaranteed to develop CCI disease. Taking a simple genetic test for the gene, like a blood or tissue sample, would tell you whether or not you will definitely develop CCI disease. A positive test result would indicate with certainty that you will develop CCI disease.

Dr. Harvey has also found that under 10% of college students presently carry the XAd gene. This is an unusually low prevalence for a gene in a population or community. This means that less than 1 out of every 10 people you see on campus have this gene that will cause CCI disease. Many patients with CCI disease find it easy to decrease the frequency of infections that come with the disease. Most people experiencing CCI disease feel that they are able to lessen the physical symptoms of the disease. While it is possible for the infections to produce complications, patients often feel able to tackle the negative issues that come with CCI disease.

As a college student, it is unlikely that you have the XAd gene, which guarantees the development of CCI disease.

While CCID is serious, there is much you can do. If you have the gene, it is easy to manage the onset and progression of the disease.

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Dr. Sidney Harvey, TCU alumnus

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New gene found to be linked to immune disease in college students

Over 90% of college students have the XAd gene, according to TCU alumnus

By [Tatum Walker](#) // Posted February 20, 2015

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Is there a genetic reason some of us are getting sick and staying sick? For most of us, the answer may be yes. Fortunately, it is easy to manage symptoms of the disease if you have it.

Class of 1987 graduate Dr. Sidney Harvey may have the most concrete answer we've had in the last decade. Harvey and his research lab at Johns Hopkins University have recently uncovered a gene, XAd, which has been identified as weakly linked to the development of Continuously Compromised Immunodeficiency disease. CCI disease is a condition that can cause many infections in numerous college-aged patients. For those with the XAd gene, CCI disease is unlikely, but possible, to follow.



Dr. Sidney Harvey, TCU alumnus

“To be clear, having the gene is not directly linked to getting infections all the time. Rather, the gene is linked to developing CCI disease, which can *then* lead to you getting sick. But there is a lot you can do to decrease the likelihood of getting sick if you have the disease.” -Dr. Harvey

The disease, which is thought to be quite manageable for college students, can create serious health implications if gone unmanaged. People with CCI disease may catch a small respiratory infection that can very quickly move to pneumonia or other detrimental infections due to their compromised immune system. CCI disease can lead to problems with normal digestion, delayed growth and development, chronic inflammation, and even death from serious infection.

Those with the XAd gene are slightly more likely to develop CCI disease. Taking a simple genetic test for the gene, like a blood or tissue sample, would tell you whether or not you have a slightly increased likelihood to develop CCI disease. A positive test result would indicate that your chances of developing CCI disease are only slightly increased.

Dr. Harvey has also found that over 90% of college students presently carry the XAd gene. This is an unusually high prevalence for a gene in a population or community. This means that more than 9 out of every 10 people you see on campus have this gene that may cause CCI disease. Many patients with CCI disease find it easy to decrease the frequency of infections that come with the disease. Most people experiencing CCI disease feel that they are able to lessen the physical symptoms of the disease. While it is possible for the infections to produce complications, patients often feel able to tackle the negative issues that come with CCI disease.

As a college student, it is likely that you have the XAd gene, which slightly increases your chances of developing CCI disease.

While CCID is serious, there is much you can do. If you have the gene, it is easy to manage the onset and progression of the disease.

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APPENDIX B: SURVEY LINK

http://tcucommunication.co1.qualtrics.com/jfe/preview/SV_9Gqh16xhDgfKsBv

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