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Segmenting by Risk Perceptions: Predicting Young Adults' Genetic-Belief Profiles with Health and Opinion-Leader Covariates

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Abstract

With a growing interest in using genetic information to motivate young adults' health behaviors, audience segmentation is needed for effective campaign design. Using latent class analysis, this study identifies segments based on young adults' (*N* = 327) beliefs about genetic threats to their health and personal efficacy over genetic influences on their health. A four-class model was identified. The model indicators fit the risk perception attitude framework (Rimal & Real, 2003), but the covariates (e.g., current health behaviors) did not. In addition, opinion leader qualities covaried with one profile: those in this profile engaged in fewer preventative behaviors and more dangerous treatment options, and also liked to persuade others, making them a particularly salient group for campaign efforts. The implications for adult-onset disorders, like alpha-1 antitrypsin deficiency are discussed.

Keywords

audience segmentation; genetic beliefs; risk perception attitude framework; opinion leadership; young adults

In a recent article, Feero, Guttmacher, and Collins (2008) described a time in the near future when Amy, aged 21, receives her complete genome sequence, her genetic risks for an array of health conditions, and advice from her physician on how to modify her lifestyle in accordance with her genetic risks. The authors pointed out that the scenario is scientifically and technically achievable; they also shared their concerns about a lack of lay knowledge of how to interpret and use genomic information. We note an additional concern: young adults have little representation in existing studies of genetic beliefs.

This omission is ironic given that young adults (18–26) are able to buy genetic tests and to act based on the results (Feero, Guttmacher, & Collins, 2008). Young adults may seek testing to obtain definitive answers about their family history (e.g., Huntington's status, McLean, 1998) or before pregnancy (Decruyenaere, Evers-Kiebooms, Welkenhuysen,

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Bande-Knops, Van Gerven, & Van den Berghe, 1995; James, Holtzman, & Hadley, 2003). Direct-to-consumer (DTC) advertisements have targeted young adults, such as asymptomatic, young women with family histories of cancer for the BRCA 1/2 test (McBride, Wade, & Kaphingst, 2010), and children as young as 1 year old to predict sports performance (Brooks & Tarini, 2011).

NIH has expressed a growing interest in developing campaigns to target young adults' use of genetic tests (Alford, McBride, Reid, Larson, Baxevanis, & Brody, 2011). Health audiences often are not homogenous, but they can be refined into homogenous segments (Rodgers, Chen, Duffy, & Fleming, 2007). Thus, the first steps in designing successful campaigns are to understand the current beliefs of the target audience and identify relevant audience segments (Slater, 1996; Slater, Kelly, & Thackeray, 2006; Maibach, Leiserowitz, Roser-Renouf, & Mertz, 2011; Maibach, Maxfield, Ladin, & Slater, 1996). To be most useful for designing campaigns, audience segmentation needs supporting theory to guide the number and meaning of audience segments. Beliefs relevant to genetic tests include perceptions of risk and efficacy; thus, the risk perception attitude (RPA) framework (Rimal & Real, 2003) is used to frame this study. Latent class analysis (LCA) is used to (a) identify coherent subgroups of young adults based on their genetic beliefs; and (b) describe these genetic-belief profiles and how many participants are members of them. In this study, we tested whether current health behaviors, opinion-leader qualities, and demographic characteristics predicted membership in different belief-classes. This covariate analysis not only provides a means to test the concept validity of RPA profiles, but also make informed decisions about with whom to intervene and how to do so well (Slater, 1996; Slater et al., 2006; Maibach et al., 1996; Maibach et al., 2011).

Genetic Risk and Efficacy Beliefs

Genetic test results can present an opportunity to learn about one's probability of facing a health condition in the future. Inherently, genetic test results, then, present risks to perceived well-being. Some scholars argue that young adults may be in the best position to use genetic information to engage in relevant prevention (Rew, Mackert, & Bonevac, 2010). This situation aligns well with RPA (Rimal & Real, 2003), extended parallel process model (EPPM; Witte, 1994), and health belief model (Rosenstock, 1966). These theories, among others, explain that risk (called threat in some theories) motivates people to actions to protect their well-being.

RPA Framework

RPA (Rimal & Real, 2003), an extension of EPPM, (Witte, 1994), explains how perceptions of risk and efficacy interact to predict health-related outcomes (attitudes and behavior). RPA focuses on how people's risk and efficacy assessments related to health issues predict health-related actions and intentions: those perceiving greater risk take more actions, but the type of action is dependent on their perceptions of efficacy (Rimal & Real, 2003). RPA complements EPPM's focus on how varying risk and efficacy content in messages may affect people's assessment. An attribute-based perspective is relevant for audience segmentation before designing campaigns (Rimal, Brown, Mkandawire, Folda, Böse, & Creel, 2009). The RPA framework results in four audience segments: high risk/high efficacy, high risk/low efficacy, low risk/high efficacy, and low risk/low efficacy (Rimal et al., 2009).

Genetic Risks and Efficacies

To use RPA to understand genetic beliefs and their alignment with health behaviors, genetic risks and genetic efficacy need to be defined. Genetic risk is considered here in two components: susceptibility and severity (Parrott, Kahl, Traeder, & Ndiaye, 2012). Genetic susceptibility beliefs identify how genes change a person's likelihood of experiencing a health condition. Genetic severity beliefs focus on how genes influence how severely a health condition will affect the carrier. Genetic efficacy varies from a genetic-driven perspective on health (genetic determinism) to a person/environmental-driven one (personal efficacy; Parrott, Silk, Weiner, Condit, Harris, & Bernhardt, 2004; Parrott, Peters, & Traeder, 2012). Genetic determinism "identifies genes as the sole relevant causal feature of an individual's characteristics and life courses" (Condit, Parrott, & O'Grady, 2000, p. 558). In contrast, personal efficacy beliefs focus on how one's actions and environment influence genes expression into health conditions (Parrott, Kahl, et al., 2012) and the genes themselves (e.g., damage or expression, etc). Parrott, Kahl, Traeder, and Ndiaye (2012) found that public beliefs align with susceptibility and severity in discussions about genes and health, and also that public beliefs reflect genetic determinism more than personal efficacy.

Genetics and Prevention

Prevention behavior can play a critical role in how some genetic-based conditions manifest. One salient example is mutations in *SERPINA1*, which leads to alpha-1 antitrypsin deficiency (AATD). AATD is linked to an adult-onset medical condition that degrades both the liver and lungs, and leads to diseases such as COPD, emphysema, cirrhosis, and lung or liver cancer (Kelly, Greene, Carroll, McElvaney, & O'Neill, 2011; Laurell & Eriksson, 1963; Sharp, Bridges, Krivit, & Freier, 1969). The prognosis for AATD is highly variable, with some people who have the genetic mutation not manifesting any symptoms while some carriers experience symptoms, such as those who smoke (Tanash, Nilsson, Nilsson, & Piitulainen, 2010). Smoking (Kelly et al., 2011; Silverman & Sandhaus, 2009) and drinking accelerate progression of AATD-related conditions (Fregonese & Stolk, 2008). Because personal behaviors can play a role in the prognosis of AATD, testing young adults can be beneficial in order to promote adaptive behavior, such as avoiding air pollutants (e.g., first or second—hand smoke).

This study, then, expands on previous studies (Parrott, Kahl et al., 2012) by focusing on specific influences on genes: respiratory and foodborne illnesses, liver and lung conditions, and smoking and drinking. Young adults are exposed to multiple alcohol and smoking prevention campaigns throughout high school and college, but the genetic relationship to alcohol, for example, has focused on a genetic basis for alcoholism (including genetic test results; Hendershot, Otto, Collins, Liang, & Wall, 2010), not on how drinking could affect one's genes. Communication to increase awareness of the role of particular gene versions in disease could guide individuals to choose behaviors or environments as intentional strategies to decrease the likelihood of expressing or multiplying the effects of genes linked to illness and disease. The gap in the literature is what are young adults' genetic beliefs and how many subgroups are there based on shared genetic beliefs?

Young Adults' Genetic Beliefs

Although little research has focused on young adults' genetic beliefs, several studies provide insights into the beliefs young adults are likely to have about genes and genetic-based risks and efficacy. Science curriculums in most high schools across the country include a segment on genetics. For example, in Pennsylvania and New Jersey (states from which this sample is drawn), education standards include information on heredity, genetic variation in humans, and the societal impact of genetic engineering (e.g., in genetically modified foods; Pennsylvania Department of Education, 2010; New Jersey Department of Education, 2009). The current curriculum, however, may not produce educated consumers of genetic or genomic information for health decisions. Teachers have expressed this concern for more than a decade (Trumbo, 2000, p. 260).

Indeed, over the past two decades, adolescents have consistently shown a poor understanding of basic genetic concepts (Decruyenaere et al., 1995; Rew, Mackert, & Bonevac, 2010). For example, although genetic tests may refer to lifetime risk, young women (18–25) with BRCA1/2 report feeling very vulnerable to cancer, and act as if they are likely to be diagnosed with cancer in the short-term, not the long-term (Werner-Lin, Hoskins, Doyle, & Greene, 2012).

The few studies on young adults' genetic risks and efficacy show a complex picture. Young adults have a deterministic view of diabetes susceptibility linked to racial and family history causes (e.g., Werner-Lin, 2007), to the neglect of behavioral causes (Dickerson, Smith, Sosa, McKyer, & Ory, 2012). On the other hand, young adults (14–21) report that one purpose for genetic testing is to identify personal risk for disease, and the information would be useful for taking preventative action (Rew, Mackert, & Bonevac, 2010). The relationship between risk and behavior may not always be positive: when young-adult smokers infer genetic susceptibility to addiction, they feel less efficacy to quit smoking (Cappella, Lerman, Romantan, & Baruh, 2005).

Targeting Young Adults

Audience segmentation is a critical step in the process of matching communication with intended outcomes, as it allows one to identify more homogeneous subgroups within a heterogeneous population (Slater, 1996). These subgroups are defined by certain shared characteristics (e.g., demographics, beliefs) associated with a given outcome. Audience segmentation research provides insight on how to plan communication campaigns that are cost-effective and that use resources strategically for marketing, advertising, and educational objectives (Maibach et al., 2011). Health communication campaigns use audience segmentation to better understand the beliefs, behaviors, and limitations of group members so that messages can be designed to effectively reshape behaviors and influence knowledge, concern, and attitudes. For example, tailored messages aiming to increase perceptions of the severity of colorectal cancer have been associated with increased intentions to obtain screening (Lipkus, Green, & Marcus, 2003).

Audience Segmentation Based on RPA—To date, RPA has not been applied to genetic beliefs. Previous studies, however, have shown that adults in Malawi could be sub-grouped into clustered based on their common levels of HIV-related risks and efficacies (Rimal et al., 2009). The four audience segments were labeled as responsive (high risk/high efficacy), proactive (low risk/high efficacy), avoidance (high risk/low efficacy), indifference (low risk/low efficacy). This study presents the first explicit test of RPA for segmenting people based on their genetic beliefs.

Multiple analytical procedures are available for audience segmentation. This study uses LCA; (Collins & Lanza, 2010), which is similar to other latent variable models such as factor models, in that it attempts to capture latent constructs from measurable variables. LCA is used when the latent construct is categorical (Collins & Lanza, 2010), as with audience segments. This leads us to our first research question:

> *RQ* 1: Does a latent class structure representing heterogeneity in genetic risk and efficacy beliefs among young adults correspond with the RPA framework?

Covariates of Young Adults' Genetic Risk and Efficacy Beliefs

LCA provides a basis for understanding how many different segments may be in an audience, and thus how many different interventions may be needed. One benefit of LCA is that it allows one to test whether particular beliefs, actions, or demographics predict the odds of membership in one class relative to another (i.e. reference class). From a theoretical perspective, current health behaviors can be used to predict membership in genetic-belief categories, which can test theoretical claims in RPA (Rimal & Real, 2003). If current health behavior does not predict membership into a particular risk-efficacy profile, then further theoretical work is needed.

RPA Covariates—To support RPA, people who do not wash their hands and who do request antibiotics for stomach or respiratory flu should be more likely to be in the indifference (low risk/low efficacy) profile in comparison to the responsive (high risk/high efficacy) profile. Pragmatically, overuse of antibiotics is a serious concern for future public health; improving antibiotic prescriptions (including patients' requests) and increasing prevention (particularly hand-washing) are critical to address future antibiotic resistance (e.g., Cookson, 2000; Jabbar & Wright, 2003). Respiratory flus are particularly serious for those with compromised lungs, such as those diagnosed with AATD. To this end, infectious disease prevention behaviors (e.g., hand-washing) and treatment (antibiotic requests) as well as expectations for serious health conditions in the future are used as covariates.

From a practical perspective, particular personality traits and demographic covariates may also be critical for making decisions about which segment to target first if resources are limited. Prioritization can be based on identifying groups who may be shaping the beliefs of others around them. Thus, it may be important to discover whether people who self-identify as agents of influence are likely to be members of particular genetic-belief profiles.

Influence Agent Covariates—Boster and colleagues (2010) described three different qualities of influence agents: mavenism, persuasiveness, and connectivity. This study focuses on mavens and persuaders. Mavens actively maintain expertise in a variety of areas, share their knowledge, and are likely to be resources for others. Persuaders find opportunities and ways to sway others to their point of view. Boster and colleagues (2010) argue that identifying people with these qualities may be useful to efforts aiming to diffuse health information via opinion leadership, especially with groups (such as young adults) who are particularly sensitive to peer influence (e.g., Gardner & Steinberg, 2005). This leads us to our second research question:

> *RQ 2:* Do covariates (hand-washing, antibiotic requests, mavenism, persuasiveness, and demographics) predict young adults' profile membership?

Method

Participants and Procedures

Undergraduate students from a multiple-section, required course at a large, eastern university participated in the study (*N*=327, 54% female, 45% male, 1% unidentified) during the summer. Participants on average were 19 years old (*Mode*=18, *SD*=1.57, *Min*=18, *Maximum*=26). Participants identified their race as White (84%), Asian (14%), African American (3%), American Indian or Alaska Native (2%), Native Hawaiian or Pacific Islander (1%). Four percent identified their ethnicity as Hispanic.

An institutional review board approved the study. Participants accessed the surveys online. After giving consent, participants were asked to report on their current behaviors (e.g., whether they had smoked a cigarette within the past hour), their current stress level, the size and diversity of their social networks, and their current health behaviors (prevention and treatment). Afterwards, they were asked to complete measures indexing their genetic beliefs, health expectations, and psychological traits (e.g., persuasiveness and mavenism; Boster et al., 2010).

Measurement

A confirmatory factor analysis of genetic belief scales—all genetic beliefs, as well as persuader and maven identification, illness expectations, and social networks—was estimated with maximum likelihood; all factors were allowed to covary, but error terms were not. The model showed reasonable goodness of fit: *RMSEA*=.05 (90% CI, .05, .06), *CFI*=.91, *SRMR*=.07, with X^2 (*df*=1169, *N*=327)=2282.12, *p*<.001 (Holbert & Stephenson, 2002).

Latent Class Indicators

Essentialism—Six items (adapted from Parrott, Kahl, et al., 2012) were used to assess the belief that genes determine disease, health, and wellbeing. Responses, marked on five-point scales (1 =*strongly disagree* to 5 =*strongly agree*), were averaged into one score (α =.83); higher scores indicate stronger essentialism beliefs.

Healthy living efficacy—Four items (adapted from Parrott, Kahl, et al., 2012) were used to assess the belief that healthy living (e.g., nutrition) can positively affect one's genes. Responses, marked on five-point scales (1 =*strongly disagree* to 5 =*strongly agree*), were averaged into one score (α =.93); higher scores indicate stronger belief in healthy living influences.

Behavioral efficacy—Three items were used to assess the belief that health behaviors (e.g., smoking, drinking, and hygiene) can affect one's genes. Responses, marked on five-point scales (1 =*strongly disagree* to 5 =*strongly agree*), were averaged into one score (α =.91); higher scores indicate stronger belief in behavioral influences.

Future health susceptibility—Seven items (adapted from Parrott, Kahl, et al., 2012) were used to assess the belief that genes make people more likely to experience future illnesses and to benefit from medical treatment. Responses, marked on five-point scales (1 =*strongly disagree* to 5 =*strongly agree*), were averaged into one score (α =.87); higher scores indicate stronger health susceptibility beliefs.

Disease susceptibility—Three items were used to assess the belief that genes make people more likely to experience foodborne, liver, or respiratory diseases. Responses, marked on five-point scales (1=*strongly disagree* to 5=*strongly agree*), were averaged into one score (α =.81); higher scores indicate stronger disease susceptibility beliefs.

Illness severity—Two items (adapted from Parrott, Kahl, et al., 2012) were used to assess the belief that genes influence the severity of an illness. Responses, marked on five-point scales (1=*strongly disagree* to 5=*strongly agree*), were averaged into one score (*r*=.70); higher scores indicate stronger illness severity beliefs.

Infectious disease threat—Three items were used to assess the belief that genes make people more likely to contract infectious diseases, more likely to transmit them to others, and more primed (as a host) to mutate disease strains into more serious forms. Responses, marked on five-point scales (1=*strongly disagree* to 5=*strongly agree*), were averaged into one score (α =.85); higher scores indicate stronger beliefs in infectious disease threats.

Covariates

Illness expectations—Six items were used to assess the perceived likelihood of experiencing viral hepatitis, tuberculosis, lung disease, COPD, liver disease, and liver cancer in one's lifetime. Responses, entered from 0 to 100% likelihood, were averaged into one score (α =.85); higher scores indicate stronger expectations of experiencing a serious illness.

Persuader—Five items (Boster et al., 2010) were used to assess identification as a persuader. Responses, marked on five-point scales (1=*strongly disagree* to 5=*strongly agree*), were averaged into one score (α =.92); higher scores indicate stronger identification.

Health maven—Five items (Boster et al., 2010) were used to assess identification as a health maven. Responses, marked on five-point scales (1=*strongly disagree* to 5=*strongly agree*), were averaged into one score (α =.89); higher scores indicate stronger identification.

Social network size—Seven items (adapted from Link et al., 1989) were used to assess how many people filled different network roles (e.g., emotional, financial). Responses, marked on five-point scales (1=*no one* to 5=*more than 10 people*), were averaged into one score (α =.81); higher scores indicate larger social networks.

Hand washing and antibiotics—Four items were used to assess current hand washing behaviors (after toileting and before preparing food) and antibiotic requests (when experiencing stomach flu or respiratory infections). Responses were marked on five-point scales (1=*strongly disagree* to 5=*strongly agree*). Items were not summarized.

Analysis Plan

Indicators for the LCA were dichotomized at the midpoint of the scale. Descriptive statistics for the indicators appear in Table 1. Binary covariates were coded so that 0=*no* and 1=*yes*. Continuous covariates were standardized as suggested by Lanza and colleagues (2007). Transforming these continuous covariates into *z*-scores allows the LCA procedure to generate standardized logistic regression coefficients, which facilitate their interpretation.

The LCA procedure provides two kinds of parameters: (a) the likelihood of providing a particular answer or response to a measured variable conditional on the set of classes, and (b) the likelihood of membership in a latent class. For example, according to RPA, one audience segment should have high efficacy and low risk beliefs; RPA does not predict how many people to expect in this segment (largest cluster in Rimal et al., 2009). LCA also provides goodness-of-fit indicators for models; these are used to select the best number of classes (e.g., four-class or five-class model).

Results

Descriptive Statistics

As shown in Table 1, young adults varied in their genetic beliefs. Often, half of the sample agreed with a particular belief, such as “genes make illnesses more severe,” and the other half disagreed. The greatest consensus was around genetic essentialism: most young adults (80%) disagreed with statements that genes determined their future health and wellbeing.

As for the covariates, young adults reported low expectations for experiencing serious illnesses in the future (M =13.85, SD =14.11); interestingly, essentialism beliefs were unrelated to illness expectations, $r(325)=.03$, *ns*. They reported minimal identification as persuaders (M=3.58, SD=0.76) and health mavens (M=3.24, SD=0.81); small networks (2–4 people available to them, M=3.13, SD=0.63); washing their hands after toileting (M=4.48, SD=0.88) and before preparing food (M=4.19, SD=0.96); and requesting antibiotics when they get the stomach flu (M=3.36, SD=1.31) and respiratory illnesses (e.g., colds or bronchitis; M=3.39, SD=1.33).

Genetic-Belief Classes

To address RQ1, Proc LCA (Lanza et al., 2007) was used to calculate fit indices for two to seven class model using 100 sets of random starting values for each test. The fit indices for these models appear in Table 2. To select the best model, AIC and BIC estimates are used such that lower scores are better (Collins & Lanza, 2010). The four-class model best fits the data, G^2=100.39, *df*=96, *AIC*=160.39, *BIC*=279.88. These findings provide an answer to RQ1: there are underlying classes of people based on their genetic beliefs.

To further explore RQ1, the two parameters generated by LCA for the four-class model were reviewed and interpreted: the likelihood of membership in a class (gamma estimates) and the likelihood of reporting a given answer (code 2 in Table 1) within the class (see Table 3).

Respondents in the largest group (34%), labeled *threatened*, believed that their genes made them more susceptible to health conditions and more likely to experience more severe reactions to or consequences of illness, but did not believe their behaviors affected their genes. The second largest group (33%), labeled *skeptics*, disagreed that their genes put them at risk for health conditions (susceptibility or severity) and disagreed that their behaviors affected their genes. Respondents in the *activists* class (24%) believed in genetic-based risks and in their own ability to affect their genes. Respondents in the *controllers* class (10%) believed in that their behaviors influenced their genes, but not genetic-based health-risks. The latent classes represent the four-category system predicted by RPA well.

One indicator, essentialism, did not differ among the classes. Notably, few people agreed with an essentialism perspective to genes (20%). Those who believed that their genes determined their health and wellbeing were not concentrated in one particular class.

Covariate Analysis

To answer RQ 2, two sets of covariates were investigated: health-related beliefs and behaviors, and psycho-demographic characteristics. The *activists* class was used as the reference class for these tests.

Health covariates—Of the five health covariates, four were statistically significant at $p < .05$. In comparison to *activists*, respondents who agreed more strongly that they washed their hands after toileting were more likely to be *threatened* or *controllers* and less likely to be *skeptics*. Respondents who agreed more strongly that they washed their hands before preparing food were less likely to be *activists* and less likely to be *skeptics*, *threatened*, or *controllers*. In comparison to *activists*, respondents who agreed more strongly that they asked for antibiotics when they were sick with the stomach flu were more likely to be *skeptics* and less likely to be *threatened* and *controllers*. In comparison to *activists*, respondents who reported stronger expectations of having a serious illness in their lifetime were more likely to be in *skeptics* or *threatened* and less likely to be *controllers*.

These findings point to specific concerns about each class. Even though they expect to have a serious illness in their lifetime, *skeptics* are less likely to engage in basic prevention behavior and more likely to ask for antibiotics to address a stomach flu. C*ontrollers*' lack of expectations of a future illness coincides with their lack of beliefs about susceptibility to illness due to their genes, suggesting an optimistic bias. Heightened expectation for a future illness among the *threatened* aligns with their perceptions of genetic-based risks for their health.

Psycho-demographic covariates—Of the eight psycho-demographic covariates, four were statistically significant at $p < .05$. In comparison to *activists*, respondents who identified more strongly as persuaders were more likely to be *skeptics* and less likely to be *threatened* or *controllers*. In comparison to *activists*, respondents with larger networks were less likely to be *skeptics*, *threatened*, or *controllers*; respondents who self-identified as White were more likely to be *skeptics* and *threatened*, and less likely to be *controllers*; and respondents who reported smoking within an hour of the survey were more likely to be *threatened* and *controllers*, and less likely to be *skeptics*. The smoking habits of *threatened* and *controllers* suggests that they may both engage in risky health behaviors, yet, threatened expected severe future illnesses (including lung disease), but *controllers* did not. Last, these findings provide additional incentive to focus initial efforts on *skeptics*: they may have smaller networks than *activists*, but their self-identification as persuaders suggests that they may diffuse their ideas to their social networks.

Discussion

This study investigated the existence of audience segments within young adults based on their genetic risk and efficacy beliefs, and how well these classes represented the categories described in the RPA framework (Rimal & Real, 2003). In addition, it tested whether current health behaviors, opinion-leader qualities, and demographic characteristics predicted membership in different belief-classes. This study's findings suggest that audience segmentation studies should be guided by theory and also include theoretically related health covariates for different segments.

Young Adults' Genetic-Belief Profiles

The results showed that a four-class model fit the data well. This model clearly represented the four categories of beliefs predicted by RPA (Rimal & Real, 2003). That said, we found reasons to relabel the groups from those proposed in early studies (e.g., Rimal et al., 2009).

We relabeled the *indifference* group *skeptics*, because they disagreed with risk and efficacy beliefs. The covariate analysis supported that relative to *activists*, *skeptics* had a higher expectation of serious illnesses. Further, *skeptics*, in comparison to *activists*, did not engage in basic public health practices (e.g., hand-washing) and requested antibiotics when they experienced stomach flu; both actions are problematic for antibiotic resistance (Cookson, 2000). Further, relative to *activists*, *skeptics* identified as persuaders (Boster et al., 2010), which is not an attribute of indifference. These findings suggest a pragmatic problem as well: health care costs related to the action of hand-washing alone could significantly reduce the costs of health care overall and benefit public health (Cookson, 2000), but Skeptics are likely to be “nay-sayers” who take few personal precautions to promote their own or others' health, and tell others not to bother with them either.

The *avoidance* group was relabeled as *threatened*. RPA asserted that the avoidance group perceives risk, but does not engage in recommended health behaviors (Rimal & Real, 2003; Rimal et al., 2009). In this study, *threatened* participants reported a mix of prevention and treatment behaviors: more likely to wash after toileting, less likely to wash before preparing food, and less likely to ask for antibiotics if suffering from the stomach flu. These findings suggest that *threatened* may attempt some recommended actions or that they may act for other reasons (e.g., they may wash after toileting for sanitation, not disease prevention). *Threatened* also more strongly expected serious illnesses in their lifetime compared to *activists*, suggesting chronic vigilance or worry about their health.

The *proactive* group was relabeled as *controllers*. RPA stated that people who believe in the efficacy of action but do not feel at risk do not engage in recommended health behaviors, because they have no motivation to do so (Rimal & Real, 2003; Rimal et al., 2009). In this study, *controllers* showed a mix of prevention similar to the *threatened*, but they held weaker expectations of facing a serious illness in their lifetime relative to *activists. Controllers* also showed almost twice the odds of requesting antibiotics for respiratory infections and higher odds of smoking before the survey compared to *activists.* Smoking puts *controllers* at risk for serious health conditions (e.g., lung disease) and for changing their genes' genetic expressions (Zhag, Day, & Ye, 2001), but *controllers* did not expect to face these conditions in their lifetime.

These findings suggest that instead of a lack of motivation to engage in self-protection, controllers may have a strong optimistic bias (Weinstein, 1984) that facilitates engagement in risky health behaviors. Indeed, unrealistic optimism in young adults presents itself when events are considered controllable (Weinstein, 1984). In this case, controllers may generally believe more in their ability to control their lives than others.

The responsive group was relabeled as *activists*, because of their tendencies to perceive both health risks from their genes and an ability to influence their genes. The RPA framework argued that this group engages in recommended health behaviors, because they have the motivation and efficacy to do so (Rimal & Real, 2003; Rimal et al., 2009). The covariate analysis showed, however, that *controllers, threatened*, and even *skeptics* engaged in more hand-washing after toileting and fewer requests for antibiotics than *activists* did. Without including covariates, we might have presumed, for example, that *activists* engage in all forms of self-protective health behaviors, when, in fact, they are not.

In addition to relabeling the groups, the proportion of young adults likely to be within each profile differed from those found in the HIV-related cluster analysis done by Rimal and colleagues (2009). In this study, *threatened* and *skeptics* represented the majority (67%), but they were the minority (totaling 18%) in Rimal and colleagues (2009).

Together, these findings suggest that attention needs to be paid to risk-efficacy theories of health behavior. Although the four-class model appears with expected indicators defining each group, the related covariates do not coincide with predictions. Indeed, few predictions are made about differences between the health behaviors of *threatened* and *controllers*. In addition, the question of when to shift from a person-centered to a message-centered approach is also unanswered. At this point, we should be able to see whether a threat message in fact moves *controllers* or an efficacy message moves *threatened* into the *activist* profile. Latent transition analysis is available to analyze transitions among profiles over time (Collins & Lanza, 2010); the theory-based experiment to intersect RPA and EPPM is needed.

Implications for Genetic Belief Research

Health communication theory consistently demonstrates that to engage in health promotion or prevention, we must feel susceptible to an ailment and believe its effects will be severe enough to interfere with our lives. This principle underlies the design of content for health messages, an operational realization of important constructs in the health belief model. Organized public health genomic communication could be designed to affect perceptions of susceptibility and severity with the aim of affecting the *controllers'* perceived risk and guide adoption of prevention practices aligned with genetic expression.

One challenge facing strategic communicators has been refining the notion of genetic determinism. Perceptions of susceptibility and severity linked to genetic risk may motivate people to choose particular behaviors or environments to decrease the likelihood of health harms related to genes. In order to maintain the belief that individuals have some control over well-being and medical responses are efficacious, communication must avoid suggesting that genes predetermine health, which would bolster essentialist beliefs. A significant finding in this research, which must be incorporated into strategic planning efforts, is that 20% of the sample held essentialist beliefs about genes and health. Further, the belief that genes predetermine health was not confined to one group of participants: all groups included some members with these views. Thus it appears necessary to emphasize that genes do not determine health.

An additional consideration is monitoring changes in genetic communication through high school curriculum and media content. A recent study (Parrott & Smith, in press) showed that simply changing the metaphor used to describe genetics—blueprint vs. instruction—increased essentialist beliefs. By continuing to monitor exposure to genetic messages, we may anticipate changing the percentages of people falling into a particular profile.

Limitations

By focusing on young adults, our findings may not generalize to other ages. Further, some young adults may have had exposure to genetic test results and conversations, because other family members were tested. Younger adults (14–17) report that their parents are an important source of information about genetic testing and of advice on how to manage the results (Rew, Mackert, & Bonevac, 2010). Thus, family exposure may be a useful covariate of genetic-belief profiles. Although we included useful covariates of positive and negative health behaviors, to fully study RPA, it would be important to also include other forms of reactance, such as berating the message or the messenger. Pragmatically, understanding who may have a pre-existing doubt about genetic studies or genetic counselors is critical for message design.

Practical Advice

Pragmatically, cost-effectiveness may suggest that targeted-interventions may be made for groups consisting of at least 10% of the sample (Parrott et al., 2004). This rule of thumb may suggest waiting to focus on *controllers* because only 10% of young adults may fit this profile. *Controllers* tended to be younger than *activists*; therefore, it is possible that young adults grow out of this profile over time. Efficacy, personal mastery, and control are noted to be fluid perceptions that change over the lifespan and vary by domain (see Berry & West, 1993 and Skinner & Zimmer-Gembeck, 2011 for reviews). The general trend is for self-efficacy to increase from young to late adolescence, and then to decline from young to late adulthood. One reason for shifts can be changes in efficacy appraisals based in self-comparisons or other-comparisons; those relying on self-comparisons to past performance history (ability to control sickness before) tend to have higher and retain higher self-efficacy than those relying on other-comparisons. The transition from adolescence to adulthood is marked by cognitive development in self-reflection, imaging alternative futures, and coordinating multiple perspectives on a problem as well as by more domain-specific experiences (Skinner & Zimmer-Gembeck, 2011). Importantly, young adults also may shift in placing health decisions in their parents to locating the decision within themselves (Albano et al., 2003). These lifespan and domain-specific changes can make young adults difficult to categorize and target appropriately. Future studies may benefit from watching how young adults transition between profiles over time.

Based on size, we might focus on either the *threatened* or *skeptics*. For *threatened*, it is possible that an efficacy-inducing intervention may shift them into action, but they may require additional cessation messages, such as to stop smoking. *Skeptics* may need an efficacy and threat intervention, except that this group already is willing to expect a future illness. *Skeptics* may need to perceive immediate threats, which may be a terrific challenge for genetic-based risks for health conditions.

Skeptics may be a particularly critical group because of their identification as persuaders: they may intentionally attempt to convince others to believe and act as they do. Boster et al. (2010) argued that opinion leadership scales could be used to identify critical persons to assist with diffusion; however, those with such qualities may not hold the beliefs or engage in the behaviors that align with a campaign's efforts. In this case, *skeptics* could provide active counter-influences to campaign efforts. For opinion leadership work, this study's findings suggest that future exploration into persuaders' general resistance to beliefs may be important.

Conclusions

The lay public is increasingly exposed to personalized medicine in the form of genetic or genomic test results (Kolor et al., 2012). Indeed, 4% of our young adults reported receiving genetic tests for themselves. Interventions attempting to change college students' behavior (e.g., drinking) are increasingly using genomic tests and genetic-related threat information for motivation to adopt healthier habits (e.g., Hendershot et al, 2010). Our findings show that almost half of the young adults believed in genetic-based risks for their health and in their ability to influence their genes. As young adults are more exposed to information about their genes, they may need guidance in how to understand them, discuss them, and make decisions related to them. This study suggests that young adults approaching such conversations may vary in their perceived risk and efficacy. With such information in hand, we can anticipate these differences and develop strategies to generate relevant messages help young adults make the best use of this information.

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Table 1

Indicators for Latent Class Analysis (*N*=327)

Indicators [name]	**Code**	**Label**	**Frequency**	**Percentage**	***M***	***SD***
Essentialism	1	Disagree	260	80	2.34*	0.56
	2	Agree	67	20	3.53*	0.37
Health living efficacy	1	Disagree	168	51	2.25*	0.75
	2	Agree	159	49	4.04*	0.54
Behavioral efficacy	1	Disagree	198	61	2.20*	0.79
	2	Agree	129	39	4.01*	0.52
Future health susceptibility	1	Disagree	126	38	2.55*	0.55
	2	Agree	201	62	3.73*	0.42
Disease Susceptibility	1	Disagree	184	56	2.64*	0.50
	2	Agree	143	44	3.82*	0.43
Illness Severity	1	Disagree	157	48	2.52*	0.62
	2	Agree	170	52	3.98*	0.43
Infectious disease threat	1	Disagree	169	52	2.57*	0.58
	2	Agree	158	48	3.84*	0.45

* significantly different from the mid-point of the scale (3) at $p < .05$.

Table 2

Comparison of Latent Class Models

Number of classes	G^2	AIC	BIC	*df*
2	223.76	253.76	310.60	112
3	153.12	199.12	286.29	104
4	**100.39**	**160.39**	**279.88**	**96**
5	83.51	161.51	309.31	88
6	68.6	162.6	340.73	80
7	59.46	169.46	377.91	72

Note. Boldface type indicates the selected model. AIC=Akaike's Information Criterion; BIC=Bayesian Information Criterion; df=degrees of freedom.

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Table 3

Item-Response Probabilities for Four-Class Model Given Latent Class Membership

	Skeptics	**Threatened**	**Controllers**	**Activists**
	33%	**34%**	**10%**	**24%**
Essentialism	.07	.17	.35	.38
Healthy living efficacy	.11	.35	**.97**	**1.00**
Behavioral efficacy	.07	.19	**.82**	**.94**
Future health susceptibility	.07	**.93**	.50	**.96**
Disease susceptibility	.03	**.74**	.00	**.74**
Illness severity	.05	**.82**	.18	**.88**
Infectious disease threat	.05	**.72**	.08	**.91**

Note: Percentages reflect the number of participants likely to be in each profile. Cells contain the likelihood of *agreeing* with the concept. Likelihoods over 50% have been bolded.

Table 4

Covariate Analysis with Activists as the Comparison Class

	Skeptics		Threatened		Controllers		
	OR	***B***	***OR***	***B***	***OR***	***B***	**LL^2**
Model 1							
Hand-washing: toilet	0.84	−0.18	1.62	0.48	1.09	0.09	11.91*
Hand-washing: food prep	0.85	−0.16	0.51	−0.68	0.61	−0.50	11.90*
Antibiotics: stomach flu	1.14	0.13	0.71	−0.35	0.48	−0.73	8.21*
Antibiotics: respiratory	0.89	−0.11	1.05	0.04	1.91	0.65	5.76
Illness expectations	1.47	0.39	1.54	0.43	0.90	−0.10	9.82*
Model 2							
Persuader	1.27	0.24	0.00	−6.39	0.01	−4.71	8.39*
Health mavens	0.65	−0.43	0.79	−0.24	1.36	0.31	2.25
Social network	0.83	−0.19	0.77	−0.26	0.63	−0.46	9.26*
Gender	0.74	−0.30	1.22	0.20	0.69	−0.38	0.92
White	1.22	0.20	1.04	0.04	0.55	−0.60	9.28*
Age	0.86	−0.15	4.23	1.44	0.68	−0.38	6.36†
Smoked before survey	0.99	−0.01	1.29	0.25	1.24	0.22	10.34*
Stressed	0.88	−0.13	0.11	−2.17	0.32	−1.13	5.74

* $p<.05$

† $p<.10$