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Online Discussion Effects on Intention to Participate in Genetic Research: A Longitudinal Experimental Study

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Abstract

Objective—The National Human Genome Research Institute has emphasized community engagement and public dialogue in the U. S. on issues related to genetics. This study examines how online discussions among the U.S. public directly or indirectly influence psychosocial constructs of the Theory of Planned Behavior (TPB), including intention to take part in genetic research.

Design—After completing the baseline questionnaire, participants (*n* = 3,754) were randomly assigned to one of the following three groups: the discussion group, the pre/post only group, and the End-Of-Project group. The discussion group (*n* = 1,824) was invited and participated in up to three online discussions, which were held from November 2008 to May 2009.

Main Outcome Measures—Behavioral intention, beliefs, attitudes, subjective norm, and perceived behavioral control variables were assessed.

Results—The most interesting finding was that those participating in online discussions had fewer negative beliefs about volunteering for genetic research, which in turn, contributed to more positive attitudes, increased injunctive and descriptive norms, and enhanced behavioral control. These relationships, then, were associated with higher intention to participate in genetic research.

Conclusion—These findings suggest that continuous public discussions seem to positively affect volunteer intention for genetic research through ameliorating fears of negative consequences.

Keywords

Synchronous online discussion; Theory of Planned Behavior; intention to participate in genetic research; mediation analysis; longitudinal experimental study

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Online Discussion Effects on Intention to Participate in Genetic Research: A Longitudinal Experimental Study

Insights from genetic research could deepen our understanding of physical and mental illnesses and help develop optimal treatment interventions (Roberts, Warner, Geppert, Rogers, & Hammond, 2005; Collins, 1999). Among the public, however, many share concerns that genetic research could lead to more discrimination, stigmatization, and other types of psychosocial harms (Roberts et al., 2005). These individuals seem to believe in genetic determinism, viewing genetic information is more definitive and predictive than other types of data (Clayton, 2003). Other studies have found that people consistently report considerable interest in genetic research (e.g., Croyle & Lerman, 1993; Braithwaite, Sutton, & Steggles, 2002), acknowledging the benefits of participating in genetic research for advancing society and assisting those at high risk for genetic illness.

The National Human Genome Research Institute, a branch of the National Institutes of Health, has emphasized community engagement and public dialogue on issues related to genetics (National Human Genome Research Institute, 2013). Further, in the report on the ethical, legal, and social implications of genetic research participation, the European Commission (2004) identified engaging in public dialogue about genetic research as one of the top recommendations to health care professionals and research scientists. The report also stated the importance of accurately reflecting the opinion of all groups.

Little research to date, however, has explored public discussions about issues of genetics with a representative sample of the U.S. public. All research on community engagement has either used focus groups or qualitative interviews with specific groups, such as employees (Roberts et al., 2005), which, although meaningful in their own light, are not broadly representative (e.g., Etchegary, Green, Dicks, Pullman, Street, & Parfrey, 2013). The importance of the public's understanding of issues related to genetics and its policy implications, as well as the limits of research, invite more systematic research into public discussion on this important health policy issue.

The main objective of this study is, therefore, to examine key factors affecting the American public's intention to participate in genetic research and, more specifically, the role of online discussion in encouraging or mitigating these intentions. The study's theoretical framework is based in the Theory of Planned Behavior (TPB), given that TPB is one of the most well established, empirically tested theories that help explain which factors contribute to intentions in a specific health context (e.g., Ajzen, 2011; Braithwaite et al., 2002).

Participating in open dialogue about controversial issues requires people to make their own views known and to expose themselves to the views of others (Price & Cappella, 2002). Such participation could lead to changes in intentions, directly or indirectly, because, according to the TPB, exposure to an intervention is one of the preceding factors in intention (Ajzen, 2011; Fishbein & Yzer, 2003). This study measures *actual*, not self-reported, online discussion participation with a representative sample of the U.S. public. This study, therefore, seeks to understand the key role that public dialogue plays in individuals' willingness to participate in genetic research.

Discussing Health Issues Online

Public dialogue or discussions has been extensively researched and investigated in the area of political communication and civic engagement (e.g, Pan, Shen, Paek, & Sun, 2006; Price, 2006; Price & Cappella, 2002, 2005; Price, Nir, & Cappella, 2006). Some scholars express concerns about the general public's inability to digest, comprehend, and draw conclusions about complex social issues, which in turn contributes to scholars doubting the value of public dialogue (Lippmann, 1992; Price, 2006). On the other hand, others hold hope in the ability of the public to express their opinions and be receptive to different views on important social issues. These scholars trust the public's ability to make informed policy decisions through these discursive activities. For instance, John Dewey (1927) posed that it was not the citizens' inability to participate, but society or government's inability to properly serve them by offering proper communication channels to facilitate quality public discourse. In other words, with the improved means of communication, participatory society could be possible (Dewey, 1927; Price, 2006). Adapting Dewey's argument for the digital era, scholars have explored public discussions online. The technological advancements have enabled many promising advances, such as reducing costs and increasing access among more challenged, dispersed, and out-of-reach populations. Such advancements also unveiled an opportunity to better reflect on the public's views on complex social issues.

Scholars, however, have debated the pros and cons of focusing on online discussions. Some argued that text-based online discussion activities would become too superficial, uncivil, shattered, and unfocused to create social capital and maintain solid discussions (e.g., Fishkin, 2000; Putnam, 2000). Kiesler, Siegel, and McGuire (1984) also raised concerns about group stereotyping, de-individualization, and anonymity's tendency to encourage uncivil discourse. Also debated were concerns about opinion-polarization, skewed communication only with like-minded people, false information distribution, reinforcement of the existing gap between people with different opinions, and technological literacy (Price, 2006; Sunstein, 2001). Others, in contrast, identified potential advantages and benefits (Cappella, Zhang, & Price, 2014). Compared with face-to-face meetings, the nature of the computer-mediated discussions seemed to help reduce social pressure or individual dominance, encouraging exchanges of unique ideas and more open-minded dialogues from socioeconomically underrepresented populations (e.g., Dennis, 1996; Rains, 2005; Walther, 1995). Moreover, Tidwell and Walther (2002) have found that when engaging in computer-mediated online discussions, individuals ask more questions about a given issue, reveal their identities more often, and have fewer superficial dialogues, relative to offline discussions. Other scholars have found similarly positive effects of online public discourse, arguing that, in fact, the lack of physical presence, anonymity, and less visible social and individual cues were beneficial not detrimental (Bargh, McKenna, & Fitzsimons, 2002).

Further, different types of chat room style forums and online discussion groups have potential to provide educational and promotional opportunities to individuals who are in need of good quality information, care, and social support regarding their health (e.g., Beaudoin & Tao, 2007; Braithwaite, Waldron, & Finn, 1999; Chung, 2014; Rhodes, 2004; Tanis, 2008). For instance, Rhodes (2004) conducted an exploratory study of a chat room-based HIV prevention intervention for men who have sex with men (MSM). In the study, the chat room-based intervention was defined as “a channel of synchronous dialogue among computer users who are connected through a network of computers (p. 316).” After the analyses of user profiles and online discussions, the author concluded that the study findings suggested the positive effects of facilitated real-time online discussion participation, especially for minority populations such as MSM, thanks to the sense of anonymity and instantaneous and convenient nature of the Internet (Rhodes, 2004). Moreover, Steward and Williams (2005) have compared the unique characteristics of synchronous (real-time) and asynchronous online group discussions and found several benefits of the real-time online discussions over the asynchronous discussion type. It seems that the co-presence and the heightened sense of immediacy in the synchronous discussion type enabled more intensified interactions, more open emotional expressions, and more diverse exchanges of opinions on a given topic. Another study (Tanis, 2008) looked at the reasons behind the use of health-related online discussion forums and also found the overall positive benefits of the discussion forum use: the survey participants (n=189) had improved coping mechanisms, both socially and physically with their health conditions after discussion participation.

In the context of health care policy, Price and Cappella (2005) conducted an experimental, multi-wave, panel design study to investigate the effects of synchronous online discussions on reforms in health care policy. The authors invited a nationally representative sample of U. S. citizens and a panel of health care policy experts to real-time online discussion forums. The citizen samples were further divided into ordinary citizens and those who were interested in and informed about health care issues. The study revealed that, for health care policy decisions, the discussants, compared with control groups who did not take part in online discussions, agreed that political feasibility and reducing disparities were two of the most important factors when making insurance-related policies. Compared with a control group, they seemed to put the societal rather than personal impacts and consequences first after taking part in an online discussion. Moreover, the same authors (Price & Cappella, 2002) have found similarly positive results of online discussions within the Electronic Dialogue Project during the presidential campaign in 2000. This time, only the nationally representative U.S. citizens (no experts) participated in a series of monthly real-time online discussions about national policies and the presidential campaign. The study confirmed the positive effects of online discussions, such as facilitating social capital and political and civic engagement among the general public.

The study presented here parallels the design of the Electronic Dialogue Project (Price & Cappella 2002). In addition, the TPB framework includes an “intervention exposure” as one of the preceding background concepts to intention and behavior (Ajzen, 2011; Fishbein & Yzer, 2003). No research to date has carefully examined the role of public discussion as a type of intervention exposure on behavioral intention. Further, little research has explored the effects of actual discussion on intentions to participate in genetic research with a nationally representative sample of the U.S. public. Therefore, this study will be the first attempt to achieve these objectives.

Theory of Planned Behavior Predicting Health Behavior Intentions

The TPB is an influential theory explaining human social behavior (e.g., Ajzen 1985, 2011; Conner & Armitage 1998; Fishbein & Yzer 2003). The TPB was first introduced as an extension of the Theory of Reasoned Action (Ajzen & Fishbein 1980; Fishbein & Ajzen 1975) by adding another predictor of intention and behavior, perceived behavioral control (Madden, Ellen, & Ajzen 1992). Madden et al. (1992) explored ten different behaviors, including exercising, sleeping, taking vitamins, going shopping, drinking coffee, or washing cars to test the added construct under the TPB. Results indicated that the presence of a perceived behavioral control enhanced the explanatory power of the theory in predicting intentions and behavior. Armitage and Connor's (2001) meta-analysis also confirmed that the perceived behavioral control explained a significant amount of variance in intention and behavior, expanding the theory to behaviors that were not fully under voluntary control.

The theory posits that attitude, subjective norms, and corresponding beliefs directly and indirectly predict intention and behavior. Attitude refers to "individuals' global positive or negative evaluations of performing a particular behavior" (Armitage & Connor 2001, p. 474), whereas subjective norms are defined as "individuals' perceptions of general social pressure to perform or not to perform the behavior" (Armitage & Connor 2001, p. 474). Subjective norms are further elaborated into injunctive and descriptive norms. The injunctive norms are defined as individuals' belief about what others think should be done, whereas descriptive norms refer to what most people think they would do given the social environment they are in (Ajzen, 1988). Corresponding beliefs consist of behavioral, normative, and control beliefs, and each is assumed to be antecedent to attitude, subjective norms, and perceived behavioral control, respectively. Previous research has shown that the more positive an individual's attitude toward behavior, the stronger his or her intention to perform that behavior. Also, the more individuals see the endorsement of a behavior from significant others and close social networks, the more likely they intend to take such action (e.g., Conner & Sparks 2005; Manstead & Parker 1995). In applying TPB, Ajzen (1991) states that, "the relative importance of attitude, subjective norm, and perceived behavioral control in the prediction of intention is expected to vary across behaviors and situations" (p. 188). That is, "the type of behavior and the nature of situation" (p. 472) determine what constructs of TPB will be more influential or powerful in predicting intentions (Armitage & Connor 2001).

In the context of public health, many studies have examined TPB concepts to explain the relationship between intention and behavior (e.g., Martin, Jacobsen, Lucas, Branch, & Ferron 1999; Codori et al. 1999). One research by Farmer, Jackson, Camacho, and Hall (2007) investigated factors associated with medical research participation among African American and low socio-economic status White women using the TPB as a conceptual framework. Through the focus group and survey analyses, the study found supporting evidence of the TPB, such that the women's attitudes, social norms, and perceived behavioral control had a positive impact on their willingness to participate in medical research. Specifically, they were willing to participate if the research was relevant or beneficial to them or their family members, if the research setting (location, time, or duration) was convenient to enroll, and if the research did not include any uncomfortable or unwilling procedures to them. They also wanted to know what exactly they had to do as participants and the qualifications of the researchers before participating.

Little research (Botoseneanu, Alexander, & Banaszak-Holl 2011; Braithwaite et al. 2002; Frost et al. 2001; Roberts et al. 2005), however, has explored TPB constructs and their mediating relationships in the context of genetic research participation. Of those that have, most only tested degrees of association, not proposed mediations, among TPB variables. In the context of hereditary cancer, Braithwaite and colleagues (2002) examined the relationships among TPB constructs, but only confirmed the strong association between intention to participate in preventive genetic testing and attitudes and subjective norms. Only one study by Botoseneanu and colleagues (2011) has tested the proposed mediating mechanisms in the TPB regarding genetic testing. The authors used the Theory of Reasoned Action approach to test the effects among a representative sample of 1,824 U.S. adults of religious involvement, attitudes, knowledge, and previous experience on intention to obtain a genetic test. Attitudes, knowledge, and previous experience had significant direct effects, while religious involvement had an indirect effect through its negative effect on attitudes (Botoseneanu et al. 2011). This study, however, did not investigate relationships of other important constructs when predicting intention. The present study, therefore, fills this gap and examines a broader range of TPB constructs as they relate to the effects of online discussion on genetic research participation.

Hypotheses and Research Questions

Based on previous literature on the TPB, the following hypotheses are posed:

H1) Attitudes, injunctive norms, descriptive norms, and perceived behavioral control will be positively associated with intentions to participate in genetic research.

H2) Behavioral beliefs will be positively associated with attitudes, which in turn, will be related to high intentions to participate in genetic research.

Second, but of greater importance, is to explore the mechanisms underlying the role of public discussions online as a type of intervention exposure. According to the TPB framework, different types of intervention exposure are background variables that account for individual differences, along with demographics, personality traits, and cultural variables. The theory argues that these background variables, such as intervention exposure, could primarily have an indirect effect on intention and behavior through influencing the underlying beliefs of individuals (Fishbein & Yzer, 2003). Since other TPB components such as attitudes, social norms, and perceived behavioral control are functions of underlying beliefs about the consequences of performing the specific behavior in investigation, it would be meaningful to explore potential associations of the TPB variables with the online discussion intervention participation. The authors also claim that the relative impact of these TPB constructs on behavioral intention depends on the specific behavior and the population being studied (Fishbein & Yzer, 2003). Since little research has conducted in the area of genetic research participation, the below research questions are proposed:

RQ1) Will participating in online discussion be associated with the TPB constructs (behavioral beliefs, attitudes, injunctive norms, descriptive norms, perceived behavioral control, and behavioral intentions)?

RQ2) Will online discussion be associated with intentions to participate in genetic research, mediated through the other TPB constructs?

Method

Project Design and Recruitment Procedure

Data for this study are from the Genetics, Public Opinion, and Deliberation (gPOD) project, a multi-wave panel study conducted by researchers at a Northeastern research university from October 2008 to November 2009. The eligibility criteria for the participants were American adults aged 18 or older who were literate in English. The sample was derived from a nationally representative panel of survey respondents maintained by a research company, GfK (formerly Knowledge Networks, Inc., of Menlo Park, California). The GfK panel includes a large number of households (tens of thousands) that have been selected through random digit dialing and who have agreed to complete periodic surveys. The survey was conducted using the web-enabled KnowledgePanel®, a probability-based panel designed to be representative of the U.S. population. Initially, participants were chosen scientifically by a random selection of telephone numbers and residential addresses. To further achieve sample representativeness, an African American oversample was included (on a modest level) to accurately account for local areas that were high in population density in non-White groups. The processes ensured the sample to resemble the U. S. Census for primary demographics, resulting in a stratified random sampling design. Persons in selected households were then invited by telephone or by mail to participate in the web-enabled KnowledgePanel®. For those who agreed to participate, but did not already have Internet access, GfK provided at no cost a laptop and ISP connection (a small percentage of the panel). People who already had computers and Internet service were permitted to participate using their own equipment. Panelists then received unique login information for accessing surveys online, and then were sent emails throughout each month inviting them to participate in research (Dennis, 2010). All surveys—baseline, pre-discussion, post-discussion, and End-of-Project (EOP) surveys—were conducted online, and all discussions occurred online synchronously.

The gPOD data were collected longitudinally after randomly assigning treatment (e.g., discussion condition) and control (e.g., pre/post or EOP condition) groups. Specifically, after completing the baseline questionnaire, participants ($n = 3,754$) were randomly assigned to a discussion group (treatment), a pre/post only group (control I), or the EOP group (control II). The discussion group ($n = 1,824$) was invited to participate in up to three online discussions between November 2008 and May 2009. The participants in the discussion group were asked to complete surveys before (pre-) and after (post-) each discussion, regardless of their attendance in the online discussions. In October 2009, they were contacted again for the final EOP survey participation. The pre/post survey group ($n = 398$) was asked to respond to all of the surveys (baseline, all pre/post-discussion, and EOP surveys) without taking part in online discussions. The EOP group ($n = 1,532$) was asked to complete the baseline and EOP surveys only. See Figure 1 for the CONSORT flow diagram of study participants.

Online Discussion Intervention

Three online discussions were held for the gPOD project. Each consisted of approximately sixty discussion groups. The average number of participants for all the discussions was nine, and each person contributed approximately 248 words per discussion. All the discussion sections were moderated by trained graduate students in communication or genetic counseling. Moderators followed detailed scripts that included timing information and specific 'real life' scenarios about topics related to genetic research participation. Various follow-up probes were programmed and made available to the moderators.

All discussions were synchronous: that is, participants met online at the same time and typed rather than verbally spoke their opinions and reactions. All texts were captured, time-stamped, and saved with a unique participant ID number. The average discussion time was about fifty-five minutes, and the research team closely monitored each discussion to ensure comparability in scripts and issues across subgroups. See Figure 2 for the sample discussion transcript.

As for specific discussion topics, a list of potential scenarios was initially developed on the basis of the literature review, media coverage content analysis, and extensive discussions among the project consulting and advisory group researchers. All the scenarios included balanced information from both sides of the issue under consideration. The scenarios were then, pre-tested on a nationally representative sample of the U. S. adults as an added-module to a monthly survey of approximately 250 adults conducted online by GfK. Five topics directly related to different aspects of genetic research participation were selected for final inclusion: Theses were, *duty to inform, duty to warn (family members), direct to consumer genetic testing, genetic discrimination, and racial issues in genetically targeted care.*

For the purpose of this study, 'discussion participation' was operationalized as being invited and participating in online discussion activities. We created dummy variables 1 for 'discussion' (treatment) and 0 for 'no discussion' (control I and II) groups.

Measures

Behavioral beliefs—To measure behavioral beliefs, participants indicated their level of agreement on a five-point scale (1 = strongly disagree, 5 = strongly agree) with the following statements: My participating in a genetics research study in the next 12 months will… (1) "give me access to information about my genetic health risk," (2) "put the privacy of my genetic information at risk (reverse coded)," (3) "help develop medical treatments for people like me," (4) "help scientists develop treatments for disease," (5) "make me a part of research that goes against my personal values. (reverse coded)," (6) "take away my control over how my DNA samples are used (reverse coded)," (7) "make me feel proud," (8) "make me to worry about my health (reverse coded)," (9) "lead me to regret life style choices that I have made (reverse coded)," and (10) "make me hopeful about my future health." These ten items were combined to create a behavioral beliefs index (Baseline: M=3.36, SD = .54, α = .75; EOP: M = 3.18, SD = .56, α = .78).

Attitudes—Attitudes were measured on a five-point semantic differential scale (1 = extremely unlikely, 5 = extremely likely) with the following statements: If it were no cost to you and your family, for you to volunteer to take a genetic test as part of a research study sometime in the next 12 months would be… (1) "harmful/beneficial," (2) "foolish/wise," (3) "worthless/valuable," (4) "bad/good," and (5) "difficult/easy." These items were combined to create an index (Baseline: M = 3.62, SD = .84, α = .89; EOP: M = 3.59, SD = .95, α = .93).

Injunctive norms—Injunctive norms were measured on a five-point scale (1= definitely should not, 5 = definitely should) with a single item: "If there were no cost to you and your family, would people in your life whose opinions you value most think you should or should not volunteer to take a genetic test as part of a research study sometime in the next 12 months?" (Baseline: M = 3.18, SD = .98; EOP: M = 3.02, SD = .98).

Descriptive norms—Descriptive norms were measured on a five-point scale (1 = strongly disagree, 5 = strongly agree) with a single item: "Most people like me have volunteered to take a genetic test as part of a research study" (Baseline: M = 2.65, SD = 1.02; EOP: M = 2.61, SD = 1.04).

Perceived behavioral control—Perceived behavioral control was measured on a four-point scale (1 = not confident at all, 4 = extremely confident): "If there were no cost to you and your family and you were recruited to participate in a research study requiring a genetic test, how confident are you that you could follow through on completing the research?" (Baseline: M = 2.65, SD = 1.01; EOP: M = 2.44, SD = 1.07).

Behavioral intentions—Behavioral intentions were measured on a seven-point scale (1 = very unlikely, 7 = very likely) with the following statement: "If it were no cost to you and your family and you were asked to take part in a genetics research study, how likely is it that sometime in the next 12 months you would volunteer?" (Baseline: M = 4.53, SD = 2.05; EOP: M = 3.87, SD = 2.13).

Control Variables

This study included four sociodemographic controls: age (categorical variable: 1=age 18–29, 2 = 30–44, 3 = 45–59, 4= 60 or older), gender (dummy variable: 1 = female, 0 = male), race-ethnicity (categorical variable: 1 = non-Hispanic white, 2 = non-Hispanic black, 3 = non-Hispanic others, 4 = Hispanic, 5 = non-Hispanic, two or more races), and education level (categorical variable: 1 = less than high school, 2 = high school, 3 = some college, 4 = bachelor's degree or higher). Including these controls avoided potential confounding influences of these variables on the endogenous variables of interest. Past research has identified sociodemographic differences in attitudes toward and knowledge about participating in genetic testing (e.g., Botoseneanu et al. 2011; Singer, Antonucci, & Van

Hoewyk, 2004). Baseline scores of each endogenous variable were also controlled in all the subsequent analyses.

Analytical Strategy

First, a descriptive analysis was performed to compare basic demographic characteristics of disscussion (treatment) and non-discussion (control I and II) groups. Then, zero-order corrections among propsoed endogenous variables were examined. Lastly, the structural equation modeling (SEM) techniques was impremented, with the maximum likelihood method of estimation, to test proposed research questions and hypotheses. The SEM approach is a powerful multivariate technique that offers flexible ways of estimating and interpreting potentially important causal steps among variables (Kaplan 2008). Specifically, SEM provides more simplified testing of mediation hypotheses since it is designed to run a single analysis to test more complicated models. Also, SEM allows longitudinal data analysis within a single framework, accomodating for clear hypothesis articulation. Last, SEM produces model fit information as to “the consistency of the hypothesized mediational model to the data and evidence for the plausibility of the causality assumptions (Gunzler, Chen, Wu, & Zhang, 2013, p. 391)”.

SEM models can be best presented by path diagrams: These path diagrams consist of nodes representing the variables and arrows representing relationshps associated with these variables (Gunzler, Chen, Wu, & Zhang, 2013). Given these advantages of the SEM mediation approach, this study uses the SEM framework to systematically examine the propsoed causal mechanisms suggested by the TPB. The exogenous variable was whether to participate in real-time online discussions at baseline (T0). The endogenous variables were behavioral beliefs, attitudes, injunctive and descriptive norms, perceived behavioral control, and intention to participate in genetic research at EOP (T1).

The proposed mediation models were tested with the SEM path analysis using Mplus Software Version 6 (Muthen & Muthen 2004). On the basis of the model modification indices, the best fitting model was identified and fianlized with an excellent model fit. To evalute the overall model fit, different fit indices were inspected: Chi-square test, Root Mean Square Error of Approximation (RMSEA), Standardized Root Mean Squre Residual (SRMR), Comparative Fix Index (CFI), and Tucker Lewis Index (TLI). Among those, the chi-square test has been unreliable due to its large dependence upon sample size (Bollen, 1989). Due to the limitation of chi-squre as a goodness-of-fit test, other more accurate measures of model fit were included in the study: CFI and TLI are related to the total variance accounted by the model, values higher than 0.95 indicate a good model fit. RMSEA and SRMR are related to the variance of residuals, values below 0.05 indicate a good model fit (Browne & Cudeck, 1993).

Results

Demographic Characteristics

Age, gender, education, and race-ethnicity were included in the subsequent analyses. We compared the demographic characteristics of the participants in the discussion and no discussion groups at baseline and found no significant differences, except for education (see Table 1). Zero-order correlations among the endogenous variables were presented in Table 2.

Model Specification, Modification, and Model Fit

We performed a series of SEM-based path analyses to explore the potential positive roles of discussion and the proposed causal mechanisms based on the TPB framework. We refined the structural equation models following standard model modification approaches (Bollen 1989; Kline 1998). On the basis of the model modification indices, we added a few pathes to identify the best fitting model. After the modification procedures, the final model showed an excellent fit, producing a chi-square value of 127.45 with 30 degrees of freedom ($p = .001$), RMSEA value of .04, SRMR value of .03, CFI value of .98, and TLI value of .96.

Direct Effects

The final SEM model revelaed that online discussion participation was statistically significantly associated with behavioral beliefs about taking part in genetic research in a positive direction ($\beta = .043$, $p < .05$). The discussion participation was also strongly positively associated with perceived injunctive norms ($\beta = .054$, $p < .01$) and behavioral control ($\beta = .070$, $p < .001$). Attitudes ($\beta = .016$, *n.s.*), descriptive norms ($\beta = .010$, *n.s.*), and behavioral intentions ($\beta = .017$, *n.s.*) about genetic research participation, however, were not directly affected by the online discussion participation activities.

Behavioral beliefs were strongly positively associated with all the other endogenous variouables in the study: attitudes ($\beta = .563$, $p < .001$), injunctive norms ($\beta = .507$, $p < .001$), descriptive norms ($\beta = .339$, $p < .001$), behavioral control ($\beta = .445$, $p < .001$), and behavioral intentions ($\beta = .197$, $p < .001$).

Attitudes ($\beta = .264$, $p < .001$), injunctive norms ($\beta = .129$, $p < .001$), descriptive norms ($\beta = .108$, $p < .001$), and perceived behavioral control ($\beta = .153$, $p < .001$) were all significantly positively associated with behavioral intentions of participating in genetic research in the next 12 months.

Indirect Effects

Online discussion participation indirectly and positively influenced attitdues ($\beta = .024$, $p < .05$), injunctive norms ($\beta = .022$, $p < .05$), descriptive norms ($\beta = .015$, $p < .05$), behavioral control ($\beta = .019$, $p < .05$), and behavioral intentions ($\beta = .008$, $p < .05$) via behavioral beliefs. Moreover, participating in online discussions increased the general public's behavioral intentions to take part in genetic research through the enhanced beliefs and then through enhanced attitudes ($\beta = .006$, $p < .05$), injunctive norms ($\beta = .003$, $p < .05$), descriptive norms ($\beta = .002$, $p < .05$), and perceived behavioral control ($\beta = .003$, $p < .05$). See Table 3 for detailed direct and indirect effects among these variables. Also see Figure 3 for the final model visualization.

To offer more nuanced assessment of the discussion intervention participation, the additional SEM analysis on the different degrees of online discussion participation was conducted. Individuals who participated in discussions all three times, two times, one time, and no discussants from the two control groups were systematically analyzed and compared. The study found much similar mediation patterns as the main discussion participation analysis, such that the online discussion participation indirectly – not directly – positively influenced intention to take part in genetic research through enhanced attitudes, injunctive, descriptive norms, and perceived behavioral control. Most importantly, the higher the degree of discussion participation is, the more the willingness to participate in genetic research is through other TPB variables. The specific direct and indirect effects were reported in Figure 4.

A Post Hoc Analysis

Although the TPB assumes no relationship between behavioral beliefs and injunctive norms, descriptive norms, and perceived behavioral control, our results indicate significant, positive associations between behavioral beliefs and injunctive norms, descriptive norms, and perceived behavioral control. These relationships, in turn, positively influence intention to participate in genetic research. To parse these relationships, we conducted an exploratory factor analysis on the behavioral belief items (see Table 4 for factor loadings, communalities, and descriptive statistics).

The analysis revealed that online discussion participation seemed to change behavioral beliefs about negative consequences of genetic research participation (e.g., “put the privacy of my genetic information at risk”). The same discussion participation, however, did not change beliefs about any positive consequences of genetic research participation (e.g., “help scientists develop treatments for disease”). In other words, online discussion contributed to reducing beliefs about negative consequences and as such facilitated intention to participate in genetic research through enhanced attitudes, subjective norms, and perceived behavioral control.

Discussion

The study examined whether a series of computer-mediated, online public discussions would directly or indirectly influence various TPB constructs, including intention to take part in genetic research. Consistent with the TPB framework, attitudes, injunctive norms, descriptive norms, and perceived behavioral control were positively associated with high intention to participate in genetic research. Behavioral beliefs were positively associated not only with attitudes but also with injunctive norms, descriptive norms, and perceived behavioral control. These TPB constructs, in turn, were associated with high intention to participate in genetic research.

For the TPB proposed causal process, the structural equation modeling analysis revealed that behavioral beliefs, injunctive norms, and perceived behavioral control regarding the willingness to take part in genetic research were directly and positively influenced by online discussion participation. Online discussion, however, did not directly influence the willingness to participate in genetic research. Those participating in online discussions had fewer negative beliefs about volunteering for genetic research at follow-up. Fewer negative beliefs, in turn, contributed to more positive attitudes, increased injunctive and descriptive norms, and enhanced behavioral control in genetic research participation. The online discussion process thus appears to ameliorate fears of negative consequences more than increasing awareness of positive consequences. The participants discussed the social and ethical implications of genetic research participation such as whether to inform participants and their family members about DNA test results or possible discrimination circumstances based on genetic research results. Since both sides of the issues were presented and carefully discussed, the balance and depth of the online conversations seemed to contribute to reducing the fear of unknown or unnecessarily exaggerated concerns about the topic among the public. Subsequently, more systematic research with the discourse itself should be able to reveal how what is said reduces negativity in beliefs. Finally, the increased attitudes, norms, and perceived behavioral control contributed to increasing individuals' willingness to take part in genetic research, as predicted by the TPB.

Additionally, another SEM analysis revealed the more nuanced benefits of the online discussion participation by examining the different degrees of the discussion participation among the U. S. public. In other words, the frequencies of the discussion activities (0 – 3 times) among the study participants were compared and the more they participated and discussed genetic research related topics online, the higher their intentions to volunteer for genetic research participation. This relationship was not direct but indirect, mediated by other TPB concepts.

The current study is not without limitations. Measurement validity in behavioral beliefs used in this study could present issues. The behavioral belief measure consists of ten individual beliefs about the likely consequences of the behavior (Ajzen 2011) but some of the items' wording (e.g., "take away *my control over* how my DNA samples are used") may be too similar with the wording of control beliefs, producing positive associations with the concept of perceived behavioral control. Fishbein and Ajzen (2010) acknowledged issue in other studies of the TPB as the behavioral beliefs, when comprehensive, may include components that are social and efficacy oriented in their mental associations. In the current findings, however, the behavioral beliefs were still most strongly associated with attitudes compared with other TPB variables. This implies that with more well articulated beliefs measures, we may find the exact mediating mechanisms proposed by the TPB. Also, despite of the advancement of digital technologies, there is still a concern for a digital divide among underserved populations in the U. S.. The Pew Research Center estimated that 87% of American adults use the Internet but with regards to the digital literacy, lower socioeconomic status, older, and male U. S. adults who live in rural areas were less likely to use the Internet than their counterparts (Perrin & Duggan, 2015). The literacy gap has shrunk substantially over the last fifteen years, but more systematic research is needed to evaluate problems and opportunities of digital literacy and its influence on public participation in health-related online discussions and social support groups (Kontos, Blake, Chou, & Prestin, 2014).

Despite the limitations, the current study uniquely contributes to the existing body of the literature in health communication and public dialogue. Specifically, by using panel experiment data with representative U.S. adults, the current study offers theoretical and methodological insights for understanding underlying mechanisms that drive health-related behavioral intentions.

First, the study confirms that online discussion has positive consequences for intentions to participate in genetic research one year in the future. Any type of intervention exposure is an understudied concept under the TPB, and this is the first attempt to explore, with longitudinal data, actual online discussion exposure and its direct and indirect effects on behavioral intention. Second, the study investigated public intentions to participate in genetic research broadly, rather than related to a particular disease or a particular population (e.g., employees). The study thus provides a more representative and applicable understanding of the 'public' perceptions of issues related to genetic research. Third, the methodological contribution of the study is to systematically explore the beneficial roles of actual online (rather than self-reported or offline) discussion about intentions in the context of genetic research participation. Many scholars agree that compared with self-reported measures of discussions, actual behaviors better reflect intentions (e.g., Price & Cappella 2002, 2005; Putman 2000). Fourth, the current study used a synchronous online discussion format for the treatment condition. As discussed previously in the literature review, this format can offer a couple of advantages over an asynchronous type: the co-presence and the sense of immediacy are two important contributing factors for active discussions with more expressive emotional reactions and more diverse opinion exchanges (Steward & Williams, 2005). Finally, Fishbein (1997) argues that the usefulness of models such as the TPB is their power to help design effective interventions to change behavior. This study's findings are informative as such because they prevent intervention designers and researchers from underestimating the positive effects on intention of exposure to discussions. Given that the direct effects were not significant, intervention designers might have jumped to the conclusion that participating in discussions was ineffective in influencing intentions if the TPB preceding factors and their mediating mechanisms had not been identified and explored. Our study findings, therefore, are beneficial in designing programs to encourage the general public to take part in genetic research.

In conclusion, public's participation in genetic research has been a controversial issue with several advantages and disadvantages (Braithwaite, Sutton, & Steggles 2002; Clayton 2003; Collins 1999; Roberts, Warner, Geppert, Rogers, & Hammond 2005). In support of the National Human Genome Research Institute's emphasis on the community engagement and public discussion on genetic research participation (National Human Genome Research Institute, 2013), this study offers strong empirical evidence that synchronous online discussion can have indirect positive effects on facilitating the intention to participate in genetic research through reduced negative beliefs as well as through enhanced positive attitudes, perceived behavioral control, injunctive, and descriptive norms after one year.

There has been a consistent need for more public education about genetic research and a recent focus group study also identified discussing the issue with others as one of the suitable educational strategies for the public engagement (Lemke, Wolf, Hebert-Beirne, & Smith, 2010). Therefore, for social, ethical, and practical reasons, it is imperative that the public is well informed to play a vital role in genetic research decision-making (e.g., DNA data sharing) and become inclusive and participatory in related policy debates, along with policymakers and genetic scientists (Dresser, 2014).

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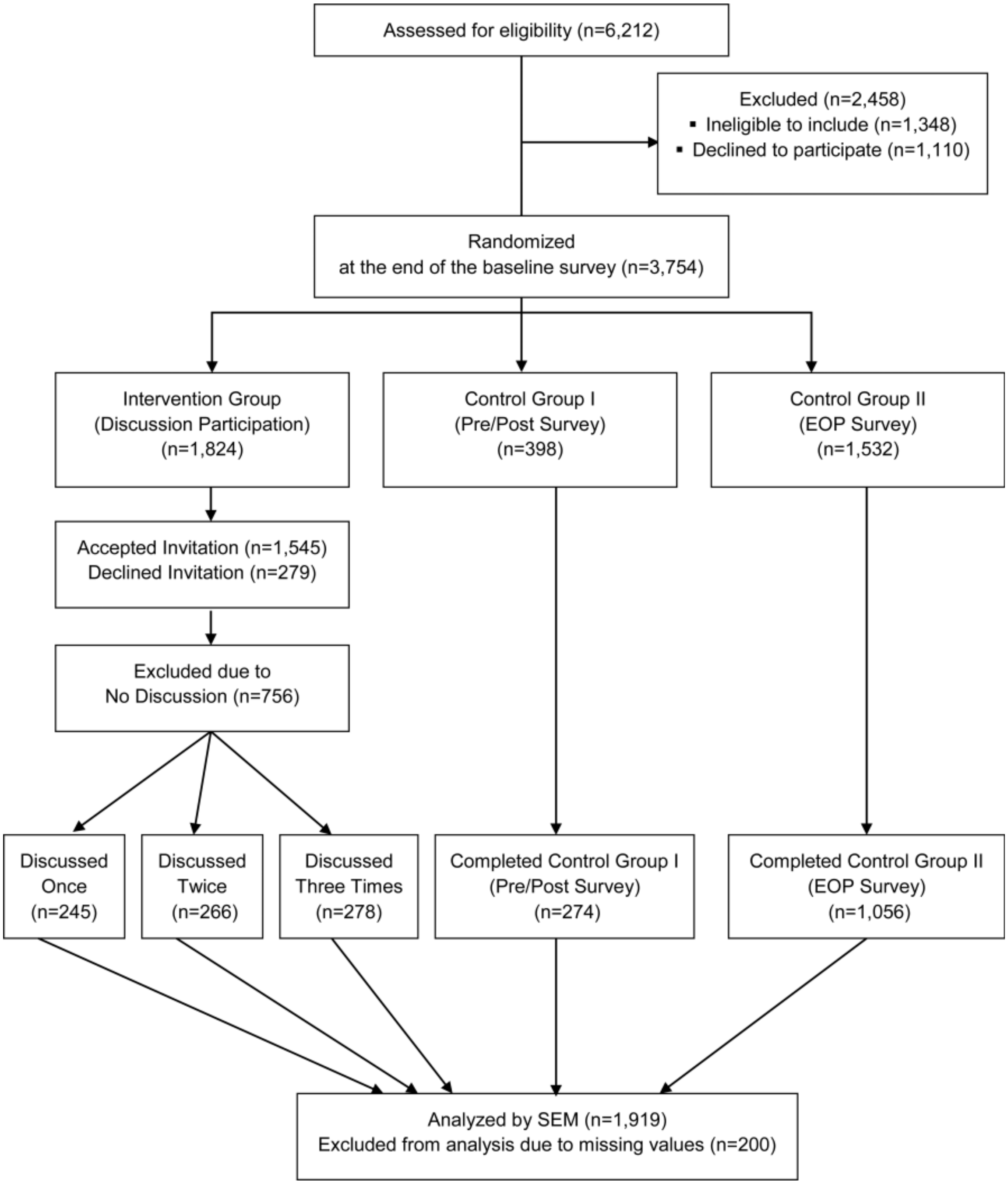
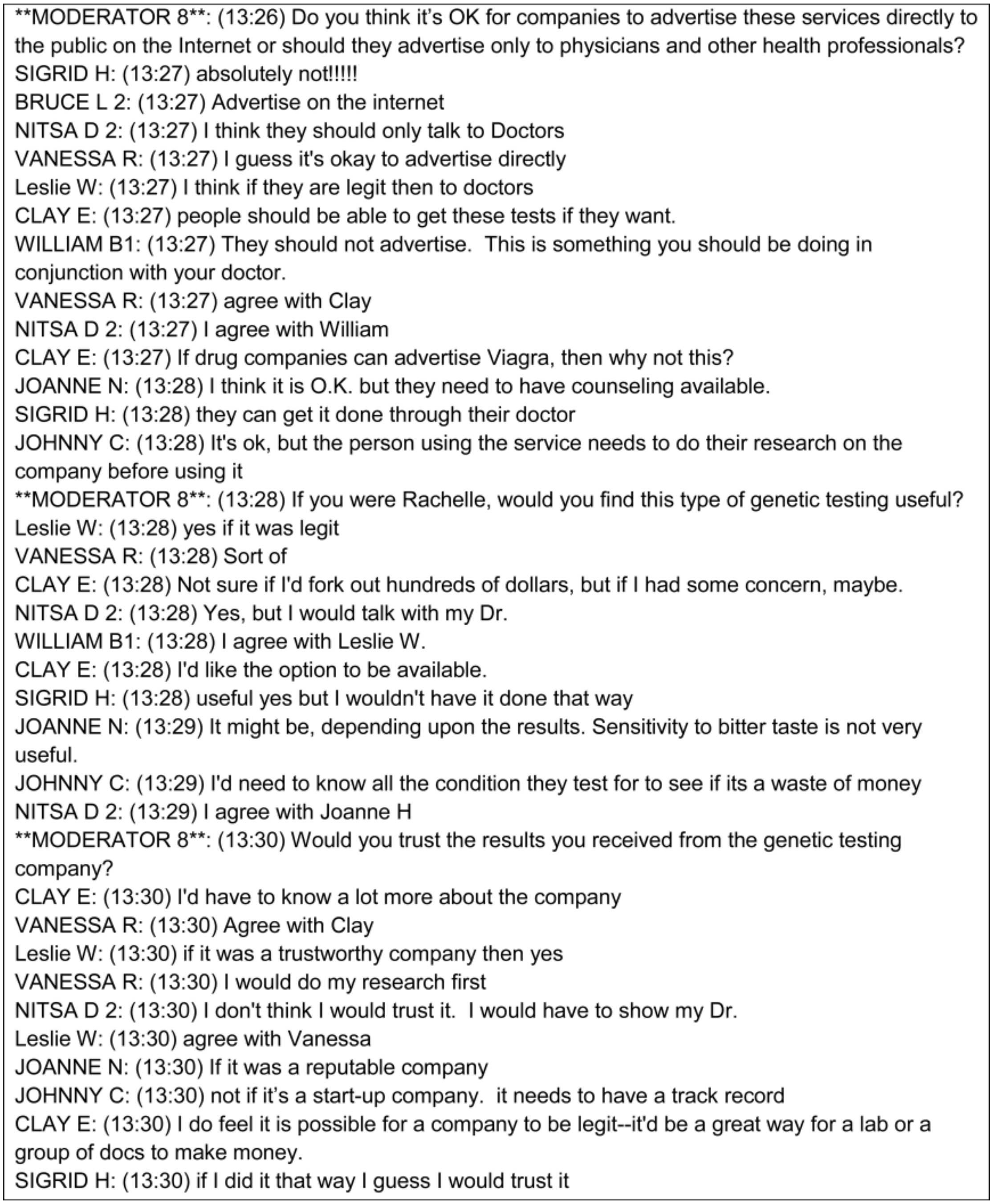


Figure 1.

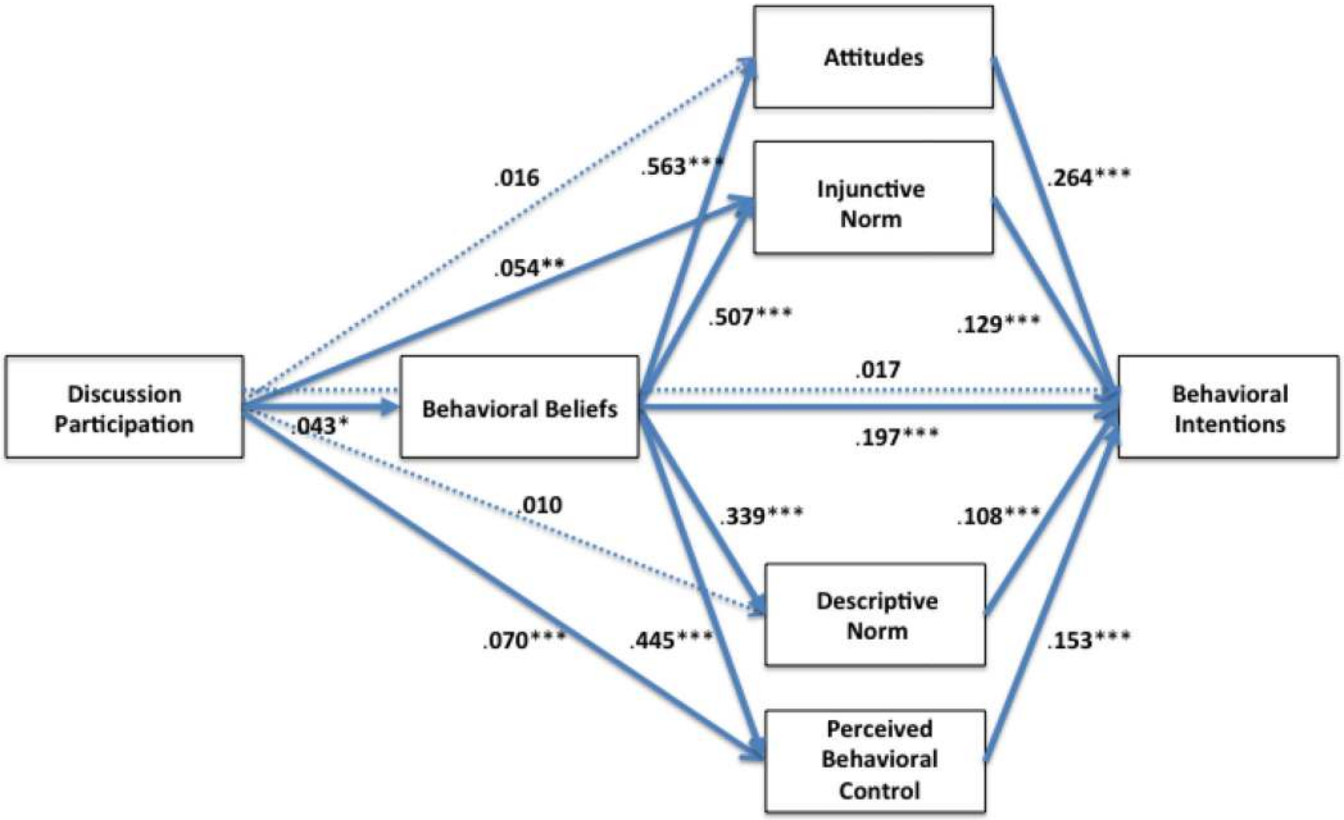
The CONSORT Flow Diagram of Study Participants



MODERATOR 8: (13:26) Do you think it’s OK for companies to advertise these services directly to the public on the Internet or should they advertise only to physicians and other health professionals?
SIGRID H: (13:27) absolutely not!!!!!
BRUCE L 2: (13:27) Advertise on the internet
NITSA D 2: (13:27) I think they should only talk to Doctors
VANESSA R: (13:27) I guess it's okay to advertise directly
Leslie W: (13:27) I think if they are legit then to doctors
CLAY E: (13:27) people should be able to get these tests if they want.
WILLIAM B1: (13:27) They should not advertise. This is something you should be doing in conjunction with your doctor.
VANESSA R: (13:27) agree with Clay
NITSA D 2: (13:27) I agree with William
CLAY E: (13:27) If drug companies can advertise Viagra, then why not this?
JOANNE N: (13:28) I think it is O.K. but they need to have counseling available.
SIGRID H: (13:28) they can get it done through their doctor
JOHNNY C: (13:28) It's ok, but the person using the service needs to do their research on the company before using it
MODERATOR 8: (13:28) If you were Rachelle, would you find this type of genetic testing useful?
Leslie W: (13:28) yes if it was legit
VANESSA R: (13:28) Sort of
CLAY E: (13:28) Not sure if I'd fork out hundreds of dollars, but if I had some concern, maybe.
NITSA D 2: (13:28) Yes, but I would talk with my Dr.
WILLIAM B1: (13:28) I agree with Leslie W.
CLAY E: (13:28) I'd like the option to be available.
SIGRID H: (13:28) useful yes but I wouldn't have it done that way
JOANNE N: (13:29) It might be, depending upon the results. Sensitivity to bitter taste is not very useful.
JOHNNY C: (13:29) I'd need to know all the condition they test for to see if its a waste of money
NITSA D 2: (13:29) I agree with Joanne H
MODERATOR 8: (13:30) Would you trust the results you received from the genetic testing company?
CLAY E: (13:30) I'd have to know a lot more about the company
VANESSA R: (13:30) Agree with Clay
Leslie W: (13:30) if it was a trustworthy company then yes
VANESSA R: (13:30) I would do my research first
NITSA D 2: (13:30) I don't think I would trust it. I would have to show my Dr.
Leslie W: (13:30) agree with Vanessa
JOANNE N: (13:30) If it was a reputable company
JOHNNY C: (13:30) not if it’s a start-up company. it needs to have a track record
CLAY E: (13:30) I do feel it is possible for a company to be legit--it'd be a great way for a lab or a group of docs to make money.
SIGRID H: (13:30) if I did it that way I guess I would trust it

Figure 2.

Sample Online Discussion Transcript

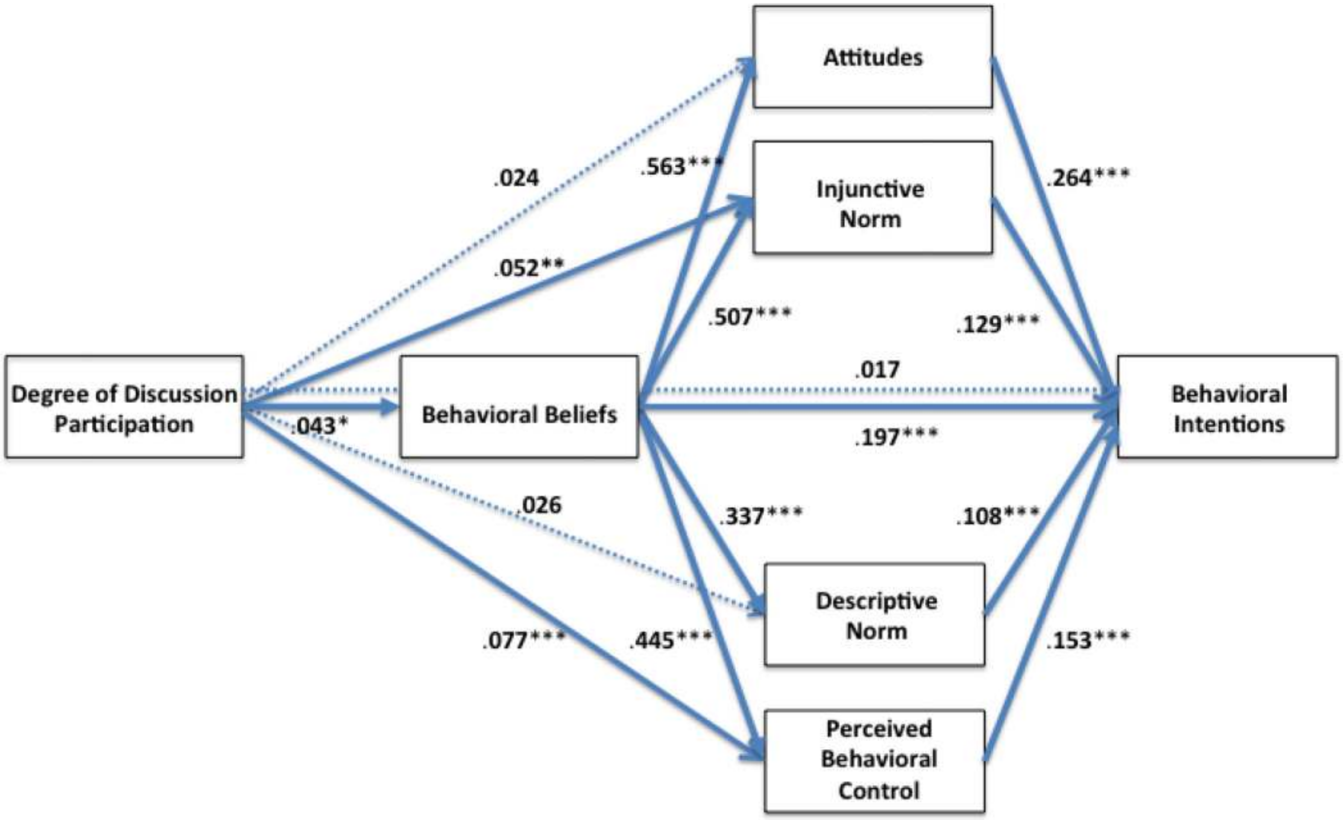


- Model Fit: χ^2= 127.45 (30), *p* = .001, RMSEA= .04, SRMR= .03, and CFI= .98, TLI= .96
- * *p* < .05, ** *p* < .01, *** *p* < .001
- Discussion Participation (1= Discussed (Treatment Group), 0= Not Discussed (Control I and II Group))

Figure 3.

Direct and Indirect Effects of Discussion Participation on Intention to Take Part in Genetic Research (EOP Sample; Baseline Score Controlled)

Note. Bold arrow lines indicate statistically significant pathways and dotted arrow lines indicate non-significant pathways.



- Model Fit: χ^2= 127.89 (30), p = .001, RMSEA= .041, SRMR= .03, and CFI= .98, TLI= .96
- * p < .05, ** p < .01, *** p < .001
- Degree of Discussion Participation (3= Discussed All Three Times, 2= Discussed Twice, 1=Discussed Once, 0= Not Discussed)

Figure 4.

Direct and Indirect Effects of the Degree of Discussion Participation on Intention to Take Part in Genetic Research (EOP Sample; Baseline Score Controlled)

Note. Bold arrow lines indicate statistically significant pathways and dotted arrow lines indicate non-significant pathways.

Table 1

Demographic Characteristics of ‘Discussion (Treatment)’ and ‘No Discussion (Control I and II)’ Participants (Baseline)

	Discussion Participants (*n* = 789)	**No Discussion Participants (*n* = 1,930)**
Age (in years)		
18–29	141 (17.9%)	360 (18.7%)
30–44	220 (27.9%)	543 (28.1%)
45–59	265 (33.6%)	583 (30.2%)
60+	163 (20.7%)	444 (23%)
Gender		
Male	340 (43.1%)	897 (46.5%)
Female	449 (56.9%)	1033 (53.5%)
Race/Ethnicity		
Non-Hispanic White	535 (67.8%)	1397 (72.4%)
Non-Hispanic Black	158 (20.0%)	353 (18.3%)
Non-Hispanic Others	22 (2.8%)	28 (1.5%)
Hispanic	54 (6.8%)	109 (5.6%)
Non-Hispanic 2+ Races	20 (2.5%)	43 (2.2%)
Education		
Less than high school	26 (3.3%)	89 (4.6%)
High school	160 (20.3%)	426 (22.1%)
Some college	231 (29.3%)	636 (33.0%)
Bachelor’s degree or higher	372 (47.1%)	779 (40.4%)

Note. Education was statistically different between discussion and non-discussion participants. Correlations among education and all the endogenous variables, however, were low showing little association among these variables (*r* ranging from - .004 to .12).

Table 2

Zero-Order Correlations among Endogenous Variables (Baseline)

		1	**2**	**3**	**4**	**5**	**6**
1	Behavioral Beliefs	1					
2	Attitudes	.62**	1				
3	Injunctive Norm	.50**	.52**	1			
4	Descriptive Norm	.30**	.36**	.34**	1		
5	Perceived Behavioral control	.57**	.55**	.49**	.30**	1	
6	Behavioral Intention	.57**	.60**	.50**	.37**	.60**	1

Note. Correlation is significant at the .01 level (2-tailed).

Table 3

Direct and Indirect Relationships between Exogenous and Endogenous Variables ($n = 1{,}919$)

	First Mediator	**Second Mediator**				**Outcome**
	Behavioral Beliefs	**Attitudes**	**Injunctive Norm**	**Descriptive Norm**	**Perceived Behavioral Control**	**Behavioral Intention (BI)**
Age	.069***	.020	−.010	−.003	−.048**	−.053***
Education	.006	−.028	−.007	.001	.077***	−.014
Ethnicity	.012	.033	.025	.056**	−.002	.001
Gender	.011	.036*	−.020	−.011	−.029	−.008
Baseline Score	.601***	.160***	.189***	.283***	.294***	.205***
Discussion Participation	.043*	.016	.054**	.010	.070***	.017
Behavioral Beliefs	-	.563***	.507***	.339***	.445***	.197***
Attitudes	-	-	-	-	-	.264***
Injunctive Norm	-	-	-	-	-	.129***
Descriptive Norm	-	-	-	-	-	.108***
Perceived Behavioral Control	-	-	-	-	-	.153***
R-Square (%)	38.0 %***	41.9 %***	36.1 %***	23.9 %***	41.0 %***	59.9 %***
Indirect Effect	Discussion → Behavioral Beliefs → Attitudes: β=.024* Discussion → Behavioral Beliefs → Injunctive Norm: β=.022* Discussion → Behavioral Beliefs → Descriptive Norm: β=.015* Discussion → Behavioral Beliefs → Behavioral Control: β=.019* Discussion → Behavioral Beliefs → Behavioral Intention: β=.008* Discussion → Injunctive Norm → Behavioral Intention: β=.007** Discussion → Behavioral Control → Behavioral Intention (BI): β=.011** Discussion → Behavioral Beliefs → Attitudes → BI: β=.006* Discussion → Behavioral Beliefs → Injunctive Norm → BI: β=.003*					

	First Mediator	Second Mediator				Outcome
	Behavioral Beliefs	**Attitudes**	**Injunctive Norm**	**Descriptive Norm**	**Perceived Behavioral Control**	**Behavioral Intention (BI)**
	Discussion → Behavioral Beliefs → Descriptive Norm → BI: β=.002 [*]					
	Discussion → Behavioral Beliefs → Behavioral Control → BI: β=.003 [*]					
Model Fit	χ^2=127.445 (30), *p*=.001, RMSEA=.04, SRMR=.03, CFI=.98, TLI=.96					

Note. Coefficients are standardized Betas (β).

Note. Only significant indirect effects are reported.

[*] p < .05,

[**] p < .01,

[***] p < .001

Table 4

Factor Loadings, Communalities, and Descriptive Statistics for behavioral belief items (EOP)

Belief Measures	**Positive Consequences**	**Negative Consequences**	**Communality**
Factor Loadings			
Help develop medical treatments for people like me	.86		.73
Help scientists develop treatments for disease	.84		.70
Give me access to information about my genetic health risk	.78		.61
Make me hopeful about my future health	.75		.57
Make me feel proud	.72		.57
Put the privacy of my genetic information at risk		.76	.62
Take away my control over how my DNA sample are used		.73	.61
Make me worry about my health		.71	.51
Lead me to regret life style choices that I have made		.52	.32
Descriptive Statistics			
Number of Items	5	4	-
Eigenvalue	3.80	1.92	
Variance (%)	37.98%	19.21%	
Mean	3.42	2.81	-
SD	.69	.72	-
Cronbach's Alpha	.86	.65	-

Note. The belief measures about negative consequences were reverse coded on a 5-point scale ranging from 1 (strongly disagree) to 5 (strongly agree).

Note. One item was dropped owing to heavy cross loading ("make me a part of research that goes against my personal values").