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On Averages and Peaks: How Do People Integrate Attitudes about Multiple Diseases to Reach a Decision about Multiplex Genetic Testing?

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Abstract

Background—The aim of the current study was to learn how people integrate attitudes about multiple health conditions to make a decision about genetic testing uptake.

Methods—This study recruited 294 healthy young adults from a parent research project, the Multiplex Initiative, conducted in a large health care system in Detroit, Michigan. All participants were offered a multiplex genetic test that assessed risk for 8 common health conditions (e.g., type 2 diabetes). Data were collected from a baseline survey, a web-based survey, and at the time of testing.

Results—Averaging attitudes across diseases predicted test uptake but did not contribute beyond peak attitudes, the highest attitude toward testing for a single disease in the set. Peak attitudes were found sufficient to predict test uptake.

Limitations—The effects of set size and mode of presentation could not be examined because these factors were constant in the multiplex test offered.

Conclusions—These findings support theories suggesting that people use representative evaluations in attitude formation. The implication of these findings for further developments in genetic testing is that the communication and impact of multiplex testing may need to be considered in the light of a bias toward peak attitudes.

Keywords

cognitive psychology; judgment and decision psychology; patient choice modeling; social judgment theory

As the field of clinical genomics develops and tests for newly discovered genetic variants are developed, it has become possible to offer packages of genetic tests for different diseases simultaneously in a single blood draw, an approach known as multiplex genetic testing.^{1,2} Although researchers have begun to assess patients' understanding and uptake of genetic susceptibility tests for a single condition (e.g., hereditary cancer, Alzheimer's disease,

hypercholesterolemia, venous thrombosis),^{3–12} multiplex testing introduces additional complexity because conditions vary in inheritance and the availability of treatment and prevention strategies.¹³ The disease risks assessed are multiple; the decision is one. The challenges for patients in understanding multiplex tests and assessing their value are still largely unknown.^{14,15} This study focuses on the influence of attitudes toward individual conditions on the choice to undergo multiplex testing.

To make an informed choice, one needs to make a decision that is consistent with one's attitudes in the context of sufficient knowledge.¹⁶ Studies to date have shown that attitudes are consistently a better predictor of positive decisional outcomes than knowledge.¹⁷ Attitudes are key predictors of intentions and behavior in the theory of planned behavior (TPB)¹⁸ and have specifically gained support in predicting uptake of genetic testing.^{4,19–24}

Multiplex testing is new, and patients may not have developed attitudes specific to multiplex tests. Yet the individual diseases included in the test may be familiar and important, and attitudes about these diseases are the most likely basis for attitude formation about multiplex testing. An attempt to model testing intentions and uptake of a multiplex genetic test by constructs from the TPB indicated that attitudes, averaged across disease risks, were the main theoretical predictor.²⁵ The present study was undertaken to address the gap in our understanding of how individuals integrate attitudes about several different diseases included on the multiplex genetic test to arrive at a decision about whether they want to be tested.

Although it has been recognized that the entity eliciting evaluative responses may represent a category of attitude objects,^{26–29} the process by which multiple attitudes toward a set of objects produce a unitary attitude is still unclear. Different principles of information integration in attitude formation have been suggested.³⁰ Some assume that an attitude reflects the weighted sum of evaluations.^{18,31} Others assume that averaging is the dominant principle in attitude formation.^{32,33} The value-account model of attitude formation^{34,35} claims that especially in emotionally charged situations, a summary evaluation of target objects, called value account, automatically accumulates without being normalized by sample size (averaged). The resulting global attitude reflects the most important aspect of experience and provides a summary of the essence of the experiences with an attitude object.

In the context of making a decision about multiplex testing, forming a global attitude toward testing can be achieved either by averaging attitudes across all diseases included in the test or by using a single representative attitude. We considered 2 potential representative attitudes: the highest (peak) attitude and the attitude toward the disease perceived by the participant to be the most important in the set. To assess which of the above attitude integration approaches is more plausible, we sought to examine the effectiveness of predicting test uptake using global evaluations based on averages as compared with evaluations based on single scores. Based on the value-account model of attitude formation,^{34,35} we hypothesized that peak or “most important” attitudes would predict people's multiplex testing decisions at least as well as average attitudes across all diseases.

OVERVIEW OF THE STUDY

We used data generated by the Multiplex Initiative, a project that sought to examine issues related to the utility of genetic susceptibility testing for 15 genetic polymorphisms associated with increased risk for 8 highly prevalent, common health conditions.^{14,36} The disease risks tested for in the Multiplex Initiative included type 2 diabetes, osteoporosis, hypercholesterolemia, hypertension, coronary heart disease, skin cancer, lung cancer, and colorectal cancer. The Multiplex Initiative offers a unique opportunity to study how people integrate attitudes about these diverse conditions to reach a decision about test uptake.

METHODS

Participants and Procedures

Participants in this study were recruited from a subset of individuals who were involved in the Multiplex Initiative. Although the goals, procedures, and structure of the Multiplex Initiative are described elsewhere,^{14,37,38} in brief, it was designed to examine the uptake and impact of multiplex genetic testing. This is a transdisciplinary research project representing a collaborative effort between the National Human Genome Research Institute (Bethesda, MD), the Group Health Cooperative (Seattle, WA), and the Henry Ford Health System (Detroit, MI). The participants were recruited from a sample of 350 000 members of the Henry Ford Health System. Enrollment required that participants be 25 to 40 years old, self-identified as Caucasian or African American, and not affected with type 2 diabetes, atherosclerotic cardiovascular disease, osteoporosis, or cancer.

Multiplex participants were recruited by telephone. They completed a baseline survey with questions about demographics, family history of diseases, and perspectives on health. They were then sent a brochure introducing the multiplex genetic test³⁶ and referred to the Multiplex Initiative website, where they were asked to complete a number of additional surveys, including the one for this ancillary study. Participants were offered a financial incentive (\$20.00) to take the survey. It was made clear to participants that they could decline the test offered to them. Those who expressed interest in multiplex genetic testing were invited to come to a Henry Ford Health System clinic to discuss the test with a research educator and to decide whether to undergo testing. If the decision was to undergo testing, a multiplex genetic analysis was performed, and participants received their mailed results informing them of their risk status. A research educator contacted participants to discuss their test results, and a follow-up survey was conducted 3 mo later.

The present study focused on the subset of multiplex initiative participants ($n = 294$) who completed the relevant questions on the baseline and ancillary web-based surveys. Participants in this ancillary study were self-selected. We paid participants an incentive to help minimize a self-selection bias. Importantly, the ancillary participants did not differ in their sociodemographic characteristics when compared with the larger group of Michigan participants.²⁵ The average age of participants in this study was 34.61 y (SD = 4.00), 51% were female, 47% were Caucasian, 53% were African American or other (some participants indicated “other”; however, this response was not used as eligibility criteria), and 63% were married or partnered. Forty-six percent had at least a college degree, another 34% had some college education, and 20% had 12 or less years of school.

Measures

Sociodemographic characteristics were assessed at the baseline interview. Gender and age were obtained from the Henry Ford Health System electronic health record. Participants' race, marital status, and educational level were obtained from the baseline survey.

Attitudes toward multiplex testing were recorded from the web-based measures. Attitudes were assessed using a semantic differential scale of 2 items based on values and beliefs about multiplex genetic testing on a 7-point scale. The text of the question was, “For me, having genetic testing for (each disease name) would be:” (*a good thing—not a good thing; a bad thing—not a bad thing*). The order of diseases was fixed: type 2 diabetes, osteoporosis, hypertension, coronary heart disease, hypercholesterolemia, skin cancer, lung cancer, and colorectal cancer. An attitude score on testing for each condition was obtained by reverse scoring one answer and averaging responses. Higher scores represented more positive attitudes toward undergoing multiplex testing. The median intercorrelation between the 2 items over the 8 conditions was 0.63.

Three attitude indices were formed: “average,” the average score across 8 diseases; “peak,” the most positive attitude score in the set (could be ascribed to 1 or several diseases); and “most important,” the score attributed to the disease that was ranked by the participant as the most important (see below).

Importance rank order was elicited using the following instruction: “Listed below are the health conditions for which you can receive genetic risk information from Multiplex Testing. Please rank them from 1 to 8 (1 = most important to 8 = least important) according to how important learning the risk information is to you. When you are finished, each item should have its own separate ranking.”

Test uptake was obtained from the outcome of the interview with a research educator in which participants decided whether or not to have blood drawn for multiplex genetic testing.

RESULTS

Descriptive summaries of attitudes toward testing, importance ranks, and the proportion of respondents who rated getting risk information a bad thing (scores 6–7 on the negative-phrased item) are presented in Table 1 by diseases (in the order in which they were presented to participants). Scores of attitudes and importance ranks covered the entire range (1–7 and 1–8, respectively) for each disease. Distributions of attitudes were nonnormal and positively skewed (skewness >2 ses); therefore, medians and interquartile ranges are reported for attitude ratings. All disease-specific medians were between 6 and 6.5, indicating a very positive attitude. The highest average importance rank was given to heart disease and the lowest to osteoporosis. The proportion of participants who rated testing for risk information as a bad thing was small (highest proportion 4.1% for diabetes).

Of the 294 participants in the study, 140 (47.6%) eventually underwent testing. Table 2 presents Pearson correlations between average, peak, and most important scores of attitudes and actual uptake of Multiplex genetic testing. The findings show that all 3 attitude scores significantly predicted test uptake. Correlation comparisons³⁹ indicated that uptake was predicted similarly by average and peak scores (Z for comparing dependent correlations = 0.32, $P = 0.75$) and that average score was marginally more predictive than the most important score (Z for comparing dependent correlations = 2.00, $P = 0.045$). Peak and most important scores did not differ significantly in their prediction of test uptake (Z for comparing dependent correlations = 1.54, $P = 0.12$).

Analyses of the subset of 23 participants (8.3%) who considered receiving risk information about at least 1 disease as a bad thing (scores 6–7 on the negatively phrased item) found that 11 (47.8%) took the test, compared with 52.2% among the others, $\chi^2(1) = 0.01$, ns . In addition, correlations between average, peak, and most important attitude scores and test uptake (controlling for age, sex, race, level of education, marital status) in this subsample ($n = 23$) were very similar to correlations obtained among the rest of the sample ($n = 217$): r 's = 0.34, 0.28, and 0.40, compared with 0.34, 0.33, and 0.28, respectively.

Average attitude scores were highly correlated with peak scores ($r = 0.87$) and with most important scores ($r = 0.88$). The correlation between peak and most important scores was also very high ($r = 0.86$). To examine whether averages contributed to prediction of test uptake above and beyond these representative scores, we performed logistic regression analyses in which demographic variables were entered in the first step, based on previous findings that older, white, and college graduate participants have greater interest in testing²⁵; either “peak” or “most important” was added in the second step; and average score was entered in the third step (Table 3). After accounting for demographic variables and peak scores, there was no significant contribution to average attitudes in the prediction of test

uptake. However, average attitudes added significantly to the prediction of test uptake after accounting for the most important attitudes score. The beginning classification accuracy was ~50%, which increased to ~70% in both analyses.

DISCUSSION

The goal of this study was to learn how people offered a multiplex genetic test would integrate attitudes about multiple conditions to reach a decision about test uptake. We focused on attitudes toward testing for each of the conditions, because attitudes were recognized as key predictors of test uptake.²⁵ One of the strengths of this study is the longitudinal design in which attitudes were measured before the testing decision and its consequences, enabling a test of prediction.

Our findings show that averaging attitudes across diseases predicted test uptake, but single attitudes, especially the peak attitude, also predicted uptake. Further analyses demonstrated that average attitudes did not contribute to test uptake prediction beyond peak attitudes. Because average scores take into account all attitudes (not just the peak), one would think that they may have an advantage in predicting test uptake. The fact that this did not happen may be interpreted as an indication for the sufficiency of cognitive shortcuts such as peak scores in predicting test uptake.⁴⁰

The heuristic value of peak attitude for reaching a multiplex decision supports the value-account model of attitude formation.^{30,41,42} Assuming that the uptake decision is emotionally charged—testing may reveal threatening information about one's disease risk—deliberate information processing is not necessary for deciding whether to be tested. The value-account based on peak attitude reflects the essence of the multiplex test and is sufficient for reaching a decision.

The difference between “peak” and “most important” scores deserves attention. Although peak attitudes were sufficient to predict test uptake, attitude toward the most important disease was not. In other words, the decision was a function of the highest attitude elicited, which was not necessarily attached to the condition judged as most important. Although highly correlated, these 2 attitude indices were not identical. There were cases in which the highest (peak) attitude was ascribed to a disease not considered as most important. We speculate that unlike the peak score, which was a direct measure of attitudes, importance rankings were based on general representations of the diseases, including attributes unrelated to oneself and to perceived benefits of testing, and thus less predictive of test uptake.

Limitations of the Study

Important questions about the effects of set size and mode of presentation could not be examined in the current study because these variables were constant in the multiplex test offered. It might also be argued that the study did not investigate directly how participants integrated their attitudes, but indirectly, through testing the relationship between attitudes and behavior. Explicit methods for tracing how participants reasoned about formulation of attitudes during the decision, such as think-aloud protocols,⁴³ may be needed to validate our conclusions about attitudes integration in multiplex testing decisions. Some literature also draws into question the stability of attitudes.⁴⁴ It is possible that if asked again at another time, attitude ratings would be different, as well as their associations with testing decisions.

SUMMARY AND CONCLUSIONS

Although multiplex testing is not yet widely available, there is a need to begin evaluating the public's interest in such testing. Initial recruitment results show that the overall uptake of the Multiplex test may be modest.³⁸ Extrapolating from our findings, we assume that increasing the number of conditions tested would increase the public's interest in testing only as much as higher peak attitudes are reached. Adding conditions that elicit attitudes within the current attitude range should not increase testing. However, another Multiplex Initiative study that asked participants for which of the 8 diseases they would like to be tested found that preference for testing for more conditions was associated with a greater likelihood of multiplex test uptake.⁴⁵ Interestingly, 78% of participants who took the multiplex test would not have chosen to receive risk information for at least 1 health condition included in the test. Thus, changes in the number and composition of the disease set in a multiplex test—either reducing the number of conditions to the ones deemed as most important among participants or increasing the set size—may affect uptake. These changes may produce more extreme judgments^{46,47} as well as changes in perceived reliability.^{48,49} Different modes of presentation may also have a significant effect on attitude formation and subsequent decisions. The influences of these processes on test uptake remain to be examined in future experiments.

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Table 1

Descriptive Summary of Attitudes, Importance Ranks, and Proportion of Participants Considering Risk Information as Bad, by Disease

Disease	Attitude (1–7) Median/ Interquartile Range	Importance Rank Mean $\pm$ SD (1– 8)	% Considering Information Bad (6–7 on Negative Item)
Diabetes	6/5–7	4.87 $\pm$ 2.19	4.1
Heart disease	6.5/5–7	6.28 $\pm$ 1.86	2.1
Hypercholesterolemia	6.5/5.5–7	4.75 $\pm$ 1.97	1.7
High blood pressure	6.5/5.5–7	4.52 $\pm$ 2.03	1.3
Osteoporosis	6/5–7	2.94 $\pm$ 2.04	1.0
Lung cancer	6.5/5–7	4.30 $\pm$ 2.29	2.8
Colon cancer	6.5/5.5–7	4.78 $\pm$ 2.08	1.3
Skeen cancer	6.5/5–7	3.56 $\pm$ 2.31	1.7

Table 2

Pearson Correlations between Attitudes (Average, Peak, and Most Important Scores) and Uptake of Multiplex Testing^a

	Test Uptake ^b	Mean	SD
Average	0.32 [*]	5.96	1.14
Peak	0.31 [*]	6.34	1.08
Most important	0.26 [*]	6.17	1.23

^aControlling for age, sex, race, level of education, and marital status.

^b0 = no, 1 = yes.

^{*} $P < 0.01$.

Results of Logistic Regression Analyses Predicting Test Uptake by (Step 1) Demographic Variables,^a (Step 2) Attitude Peak (A) or Attitude toward Most Important Disease (B), and (Step 3) Attitude Average

Table 3

A. Peak Score (in Step 2), N = 275, Beginning Classification Accuracy = 51.4%									
	-2 Log Likelihood	² Model	df	Sig.	² Change	df	Sig. Change	Nagelkerke R ²	Percentage Correct
Step 1	368.163	13.064	6	0.042	13.064	6	0.042	0.062	58.9
Step 2	336.832	31.332	7	0.000	31.332	1	0.000	0.199	66.9
Step 3	333.777	47.450	8	0.000	3.054	1	0.081	0.211	69.8

B. Most Important Score (in Step 2), N = 257, Beginning Classification Accuracy = 50.2%									
	-2 Log Likelihood	² Model	df	Sig.	² Change	df	Sig. Change	Nagelkerke R ²	Percentage Correct
Step 1	343.810	12.273	6	0.056	12.273	6	0.056	0.062	57.6
Step 2	323.886	32.201	7	0.000	19.928	1	0.000	0.157	66.1
Step 3	315.861	40.226	8	0.000	8.025	1	0.005	0.193	69.6

^aAge, sex, race, level of education, and marital status.