Published in final edited form as:

Psychol Health. 2018 May ; 33(5): 682–700. doi:10.1080/08870446.2017.1387261.

Explaining the Effects of a Decision Intervention on Mammography Intentions: The Roles of Worry, Fear, and Perceived Susceptibility to Breast Cancer

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Abstract

Objective.—This study examines the effects of a mammography decision intervention on perceived susceptibility to breast cancer (PSBC) and emotion and investigates how these outcomes predict mammography intentions.

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The authors do not have any financial conflicts of interest to disclose.

Design.—Randomized between-subjects online experiment. Participants were stratified into two levels of risk. Within each stratum, conditions included a basic information condition and six decision intervention conditions that included personalized risk estimates and varied according to a 2 (amount of information: brief vs. extended) $\times$ 3 (format: expository vs. untailored exemplar vs. tailored exemplar) design. Participants included 2,465 U.S. women ages 35–49.

Main Outcome Measures. PSBC as a percentage, PSBC as a frequency, worry, fear, and mammography intentions.

Results.—The intervention resulted in significant reductions in PSBC as a percentage for women in both strata and significant increases in worry and fear for women in the upper risk stratum. Of the possible mediators examined, only PSBC as a percentage was a consistent mediator of the effect of the intervention on mammography intentions.

Conclusion.—The results provide insight into the mechanism of action of the intervention by showing that PSBC mediated the effects of the intervention on mammography intentions.

Keywords

perceived susceptibility; perceived risk; mammography; decision aid; worry; fear

Recent changes to mammography guidelines in the U.S. (Oeffinger et al., 2015; U.S. Preventive Services Task Force, 2009; Siu, 2016) have produced substantial confusion about the optimal time for women to begin mammography. Concurrently, a growing emphasis on informed and shared decision making (e.g., Sheridan, Harris, & Woloshin, 2004) further necessitates that women be well informed about the risks and benefits of mammography and make decisions based on individual risk and preferences. Together, these two phenomena have created a need for tools to aid in women's mammography decision making. From a public health perspective, interventions regarding mammography should also have the goal of helping women make decisions that maximize their likelihood of experiencing the benefits of mammography while minimizing the risk of potential harms (Brawley, 2012; Pace & Keating, 2014).

With these issues in mind, we created a personalized risk-based decision intervention for U.S. women that was designed to improve the match between objective breast cancer risk and mammography behaviour. In [reference removed for review], we reported the effects of the decision intervention on two main outcomes of interest: accuracy of risk perceptions and mammography intentions. For lower-risk women, the intervention significantly improved the accuracy of risk perception (when risk was measured as a percentage) and significantly increased the percentage of women planning to wait until age 50 to begin mammography. For women in the upper risk stratum, the intervention resulted in significant improvements in accuracy of risk perception but had no strong corresponding effects on mammography intentions. Intention to have a mammogram at age 40 was significantly increased in only one condition (brief intervention + untailored exemplars).

Because the intervention had some, but not all, of the intended effects on intention, we needed to examine whether the intervention might have had unintended effects on other variables—namely emotions—known to influence screening. Additionally, we wanted to

explore the mechanism of action by using mediation analyses to see if predictors of intention, such as perceived susceptibility and emotion, explained the effects (or lack of effects) of the decision intervention. Although prior studies have reported the effects of mammography decision aids on risk perceptions and/or emotional outcomes, none, to the authors' knowledge, have attempted to examine how these constructs mediate changes in behavioural intention.

Effects of decision interventions on risk perceptions

In the U.S., women consistently overestimate their risk of contracting and dying from breast cancer (Hoffman et al., 2010). Consequently, improving the accuracy of breast cancer risk perceptions is a reasonable goal for breast cancer-related decision interventions, and some have succeeded in changing risk perceptions. For example, Rimer et al. (2001) found that a mammography intervention consisting of a tailored print booklet and telephone counselling resulted in improvements in accuracy of perceived breast cancer risk when compared to usual care or a tailored print booklet without counselling. These improvements in accuracy persisted at the 24-month follow-up assessment (Rimer et al., 2002). A systematic review of tailored information about cancer risk and screening provides further support for this link; Albada, Ausems, Bensing, and van Dulmen (2009) report that interventions tailored on individual risk or behaviour change variables (vs. generic materials) increased realistic perceptions of risk.

Effects of decision interventions on emotion

In contrast to risk perception, emotion as a construct is not often an intentional target of mammography decision interventions. Rather, it is measured as a secondary or process outcome. Hersch et al. (2015) report that a breast cancer screening decision aid that included information about overdiagnosis of breast cancer significantly reduced worry about breast cancer when compared to the control condition. Other reports of mammography-related decision aids typically report no effects on emotion. For example, Mathieu et al. (2007) reported that a mammography decision aid for 70-year-old women did not increase anxiety, a state related to worry. Similarly, a mammography decision aid for 40-year-old women explaining the benefits and harms of screening had no effect on feelings of anxiety (Mathieu et al., 2010). These findings extend outside the realm of mammography to general cancer-related interventions; de Nooijer, Lechner, Candel, and de Vries (2004) reported that an intervention about cancer symptoms and detection had no effects on fear.

Relationship between perceived risk and behaviour

The idea that perceived susceptibility predicts the adoption of a health behaviour is a common component in theories of behaviour change. The Health Belief Model (HBM; Janz & Becker, 1984) was originally developed, in part, to explain low uptake of screening tests. In the HBM, perceived susceptibility is one's 'subjective perception of risk of contracting a condition' (Janz & Becker, 1984, p. 2) and is considered a major predictor of behaviour. In Protection Motivation Theory (Rogers, 1983), perceived susceptibility is captured by the

‘vulnerability’ construct, which informs one’s threat appraisal and ultimately influences behaviour.

This relationship between perceived risk and behaviour or behavioural intention is well documented in the mammography arena. In a large, national, cross-sectional survey, higher perceived breast cancer risk was associated with routine mammography (Gross, Filardo, Singh, Freedman, & Farrell, 2006). Reviews and meta-analyses provide further evidence for this link. An early meta-analysis by McCaul, Branstetter, Schroeder, and Glasgow (1996) demonstrated a positive link between perceived breast cancer risk and obtaining mammography, and similar patterns have emerged in later reviews and meta-analyses (Katapodi, Lee, Facione, & Dodd, 2004; Vernon, 1999). It is important to note that the way in which perceived risk is measured may have effects on its correlation to screening; Gurmankin Levy, Shea, Williams, Quistberg, and Armstrong (2006) found that a numerical scale of perceived risk was more strongly correlated with mammography ($r = 0.19$) than qualitative verbal or qualitative comparative measures. Additionally, though the link between subjective (or ‘felt’) risk and mammography is well-documented, the link between objective or actual risk and mammography is not as strong. Lipkus, Rimer, and Strigo (1996) found that, in a multivariate model, subjective risk predicted mammography ‘stage of change’ (as defined in the Transtheoretical Model of Change; see Prochaska & DiClemente, 1983), but objective risk did not.

Relationship between emotion and behaviour

Although traditional theories of decision making under risk and uncertainty have taken a consequentialist perspective, giving preference to the role of cognitive evaluation in determining behaviour while discounting any direct effects of feelings or emotion, theories and approaches have evolved to acknowledge the important role that emotions play in shaping judgments and behaviour (Loewenstein, Weber, Hsee, & Welch, 2001). These theoretical approaches range from the risk-as-feelings hypothesis (Loewenstein et al., 2001) to fuzzy-trace theory (FTT; Reyna, 2008). The risk-as-feelings hypothesis proposes that both cognitive evaluations of risk and emotional influences (including worry and fear) can have direct influences on behaviour. In a related vein, one component of FTT is the idea that people rely on gist representations of risk (rather than precise risk information) to inform behaviours and decisions. According to Reyna (2008), the concept of gist includes the ‘emotional meaning’ of risk information. These theories suggest that health-related decisions are not strictly a product of objective risk, but, instead, include consideration of emotions experienced. This effect is seen in research by Moser, McCaul, Peters, Nelson, and Marcus (2007), who found that perceived risk and worry were both significant and independent predictors of mammography. Clemow et al. (2000) also observed a significant positive relationship between breast cancer worry and mammography contemplation that remains significant after controlling for the influence of perceived risk. Slovic, Peters, Finucane, and MacGregor (2005) draw specific attention to the critical importance of considering emotion in cancer communication. They note that, because cancer is associated with strong negative emotions, and because people tend to neglect risk probabilities when affect is very salient, people are less likely to pay attention to risk information and more likely to rely on the affect

heuristic (Finucane, Alhakami, Slovic, & Johnson, 2000) as a mental shortcut when making cancer-related decisions.

The present research

Based on the prior literature, we formed several research questions and hypotheses that guided post hoc mediation analysis of data from an online mammography decision intervention experiment. Because perceived susceptibility to breast cancer (PSBC), fear, and worry are variables that are both results of decision interventions and predictors of behaviour, we first wanted to explore the effects of our intervention on these possible mediating variables. We then predicted that PSBC, worry, and fear would mediate the effects of the intervention on mammography intentions.

Methods

The article presents analyses of data from a previously reported online experiment testing the effects of a mammography decision intervention with women in the United States. For a full description of the participants, methods, and intervention conditions, see [reference removed for review]. A synopsis of methods relevant to the present research is presented below.

Participants

This research was approved by the university Institutional Review Board. Potential participants were contacted through Survey Sampling International (www.surveysampling.com) and invited via email to participate in the study. Individuals who consented to participate were eligible for the study if they were female, between the ages of 35 and 49, and had no history of breast cancer or a genetic mutation in BRCA1 or BRCA2. Full details regarding participant completion rates and exclusion are available in [omitted for review]. A total of 2,465 participants are included in this analysis. Participant characteristics by condition are presented in Table 1. Demographic characteristics and drop-out rates did not differ significantly across these conditions. For women with a 10-year risk of breast cancer $\leq 1.5\%$, the percentage reporting a prior mammogram did differ significantly across conditions, $\chi^2(6, N = 1432) = 14.98, p = .02$.

Research design

This research utilized a between-subjects online experiment to examine the effects of a risk-based mammography decision intervention on PSBC, worry, and fear. Data were collected in September 2013 using an online survey questionnaire. Before being assigned to condition, participants completed measures of mammography history, education, insurance status, and additional measures needed to estimate objective breast cancer risk with the National Cancer Institute Breast Cancer Risk Assessment Tool (NCI BCRAT; National Cancer Institute, 2011); risk factors measured included age at menarche, age at first live birth of a child, family history of breast cancer, biopsy history, and race/ethnicity. Risk estimates were used to stratify participants into two levels of estimated breast cancer risk: 10-year risk $< 1.5\%$ and 10-year risk $\geq 1.5\%$.⁶ After stratification into two levels of risk, participants were

randomly and blindly assigned to an experimental condition within their risk stratum. Participants viewed a decision intervention, which varied by condition, and completed outcome measures, including mammography intention, perceived susceptibility to breast cancer (PSBC), and emotions experienced while reading the intervention (worry and fear).

Measures

Mammography intentions—Participants were asked to select the statement that best described their mammography intentions: ‘I will start or continue to have mammograms in my 40s,’ ‘I will have my first or next mammogram at age 50,’ ‘I will never have a mammogram,’ or ‘I am undecided.’ For women with an estimated 10-year breast cancer risk less than 1.5%, ‘I will have my first or next mammogram at age 50’ was recoded as 1 and all other responses were recoded as 0 to create a dichotomous measure. For women with an estimated 10-year risk of 1.5% or higher, ‘I will start or continue to have mammograms in my 40s’ was recoded as 1 and all other responses were recoded as 0.

Perceived susceptibility to breast cancer (PSBC)—PSBC was measured in two numeric formats, adapted from McQueen, Swank, Bastian, and Vernon (2008) and Schapira, Davids, McAuliffe, and Nattinger (2004), to capture possible format-dependent differences in reporting. First, participants were asked to estimate their susceptibility as a percentage: ‘What is your chance of developing breast cancer in the next 10 years? Please choose a number between 0% (no chance of breast cancer) and 100% (I definitely will get breast cancer).’ Participants were also asked to estimate their susceptibility using a frequency format: ‘What is your chance of developing breast cancer in the next 10 years? ____ out of 1000.’ Correlations between measures are reported in Table 2. The correlation between PSBC as a percentage and PSBC as a frequency was 0.35 ($p < .001$), which shows considerable disagreement between the two numerical formats. This is consistent with prior research showing that PSBC differs based on the measurement scale on which it is assessed (Schapira et al., 2004).

Worry and fear—Worry and fear were measured using individual items adapted from methods published by Bleakley et al. (2015). Participants were asked, ‘How much do each of the following words describe how you felt while reading the decision aid?’ and this stem was followed by the words ‘worried’ and ‘afraid.’ Participants could respond on a five-point scale from 1 (*not at all*) to 5 (*very much*) for each of these words. The correlations between worry and PSBC as a percentage and between fear and PSBC as a percentage were low (see Table 2), and neither worry nor fear was significantly correlated with PSBC measured as a frequency.

Experimental interventions

There were seven conditions within each of two strata of breast cancer risk. A full description of the content of each condition is available in [reference removed for review].

⁶The 10-year breast cancer risk threshold of 1.5% was chosen to reflect the 90th percentile of 10-year risk for 50-year-old women (omitting the 10% with the highest risk, see [reference removed]). This would represent a somewhat elevated risk for a woman between the ages of 35 and 49 (i.e., our study population), and women with an elevated risk may benefit more from mammography in their forties than women with a lower risk.

Both sets included a *basic information* comparison (control) condition, in which participants received information about then-current mammography guidelines.⁷ There were also six decision intervention conditions that included individualized estimates of 10-year and lifetime breast cancer risk calculated using the NCI BCRAT (2011) and the risk of an average-risk woman of the same age, both presented in a numeric frequency format with corresponding icon arrays. Intervention conditions varied according to a 2 (amount of information: brief vs. extended) $\times$ 3 (format: expository vs. untailored exemplar vs. tailored exemplar) factorial design.

Brief conditions included individualized risk estimates and the risk of an age-matched woman; extended conditions included this information plus the breast cancer risk of a typical 50-year-old woman and numerical risk information about mammography outcomes (e.g., false positives, breast cancers detected, deaths averted). All intervention conditions also included a final page that included reasons to have or delay mammography, but conditions varied in the format in which these reasons were presented. In the expository conditions, reasons were presented in a didactic format. In the untailored exemplar conditions, reasons were presented within two brief narratives in which example women made decisions about mammography. Finally, in the tailored exemplar conditions, reasons were presented in the context of two brief narratives in which characteristics of the example women (e.g., age, breast cancer risk, and family history of breast cancer) were altered to be similar to those of the participant. Additionally, the composition of reasons to have or delay mammography varied by risk stratum. Interventions for the lower stratum included three reasons women may wait until age 50 to have a mammogram and one reason women may choose to have a mammogram beginning at age 40; those for the higher risk stratum included one reason women may wait until age 50 to begin having mammograms and three reasons women may begin mammography at age 40.

Analysis

Because participants were stratified into two levels of risk and the content delivered to each stratum differed, the two levels of risk are analysed as separate experiments. All analyses were conducted using Stata/IC 14.2.

Ordinary Least Squares (OLS) regression—OLS regressions were conducted to examine the effect of intervention conditions on each of four potential mediators: PSBC as a percentage, PSBC as a frequency, worry, and fear.

Mediation analyses—Mediation analyses were used to obtain estimates of the indirect effect of the intervention on intention through the proposed mediators (PSBC as a percentage, PSBC as a frequency, worry, or fear). Analyses used a simple mediation model in which the effect of *X* on *Y* was mediated by *M*. *X*, *M*, and *Y* refer to condition (each risk-based intervention condition compared to the basic information condition), the mediator (PSBC as a percentage, PSBC as a frequency, worry, or fear), and the outcome variable

⁷The experiment also included a *no information* comparison condition; however, because participants in that condition were not able to complete emotion measures (which required participants to report emotions experienced while reading the decision intervention), the *no information* comparison condition is not included in the analyses reported here.

(mammography intention), respectively. Paths a , b , and c' refer to the paths between X and M , M and Y , and X and Y controlling for M , respectively.

These analyses employed a traditional regression-based approach to determine the indirect effect: The outcome variable was regressed on condition using logistic regression, the mediator was regressed on condition using OLS regression, and, finally, the outcome variable was regressed on the both the mediator and condition using logistic regression. The indirect effect was calculated by multiplying paths a and b (after each was standardized to account for differences in scaling due to the combination of OLS and logistic regression). As recommended by Hayes (2009; 2013), 10,000 bootstrap samples were used to construct a bias-corrected 95% confidence interval for the estimate of the indirect effect. If this confidence interval did not include zero, the indirect effect was judged to be significantly different from zero.⁸

Results

Effects of decision intervention on PSBC, worry, and fear

As shown in Table 3, for participants with an estimated 10-year breast cancer risk less than 1.5%, five out of six risk-based interventions reduced participants' PSBC (compared to the *basic information* condition) when PSBC was measured as a percentage. For participants with a 10-year risk $\geq 1.5\%$, all six risk-based interventions resulted in a significant reduction in PSBC as a percentage. This same pattern was not seen when PSBC was measured in a frequency format; only one intervention condition resulted in a significant change in PSBC as a frequency.

For participants in the lower risk stratum, the decision interventions had little effect on worry. Only the *extended intervention + untailored exemplars* condition resulted in a significant increase. However, for participants in the upper risk stratum, all six interventions resulted in significant increases in worry. The pattern of results is similar for fear: in the lower risk stratum, there was no effect of the risk-based decision interventions on fear, but, in the higher risk stratum, four out of six risk-based interventions led to increases in fear.

Mediators of effects of intervention on mammography intentions

Of the mediators tested, the only consistently significant mediator was PSBC as a percentage. For women with an estimated 10-year breast cancer risk $\geq 1.5\%$ (see Table 4), all of the intervention conditions were associated with a decrease in PSBC as a percentage (path a), and PSBC as a percentage was positively associated with intention to have a mammogram at age 40 (path b). Thus, the intervention had a negative indirect effect on intention through PSBC. In five out of six cases, the direct effect between intervention conditions and mammography intentions (path c') was not significant. For women with an estimated 10-year breast cancer risk $< 1.5\%$, PSBC as a percentage was a significant mediator for two condition. For the *extended intervention + expository* condition, the

⁸A significant association between condition and the outcome variable was not a pre-requisite for testing for indirect effects, as Hayes (2013), MacKinnon (2008), and other scholars have recognized that indirect effects can exist in the absence of a significant correlation between X and Y .

intervention significantly decreased PSBC as a percentage ($a = -5.36, p = .015$), and PSBC as a percentage was negatively related to intention to wait until age 50 to have a mammogram ($b = -0.03, p = .019$). The direct effect of the intervention on intention to wait until age 50 to have a mammogram was positive and significant ($c' = 1.10, p = .005$). The pattern for the *extended intervention + untailored exemplars* condition was similar ($a = -6.80, p = .001$; $b = -0.02, p = .064$; $c' = 1.39, p < .001$), thus the intervention indirectly increased intentions to wait until age 50 through PSBC. In all cases, bias-corrected 95% confidence intervals for the indirect effects based on 10,000 bootstrap samples did not include zero, suggesting significant indirect effects.

Among the remaining mediators tested, there was no substantial evidence of mediation. First, there were no significant mediation effects of PSBC as a frequency for women with a 10-year breast cancer risk $< 1.5\%$. For women with a 10-year breast cancer risk $\geq 1.5\%$, there was evidence that the relationship between PSBC as a frequency and the logit of the intention measure was non-linear, thus the methods used to test mediation are not suitable for this subset of the data. Secondly, there were only two significant mediation paths for emotion (out of 12 tests for worry and 12 tests for fear). For women with a 10-year breast cancer risk $< 1.5\%$ in the *extended intervention + untailored exemplars* condition, the intervention led to an increase in worry ($a = 0.34, p = .014$), and worry led to a decrease in intention to wait until age 50 to have a mammogram ($b = -0.37, p = .013$). The direct effect of condition on intention to wait was positive and significant ($c' = 1.65, p < .001$). For women with a 10-year breast cancer risk $\geq 1.5\%$ in the *brief intervention + untailored exemplar* condition, the intervention led to an increase in fear ($a = 0.41, p = .001$), and fear led to an increase in intention to have a mammogram at age 40 ($b = .20, p = .056$). The direct effect of condition on intention to have a mammogram at age 40 was positive but not significant ($c' = 0.19, p = .418$). Again, bias-corrected 95% confidence intervals for the indirect effects based on 10,000 bootstrap samples did not include zero, suggesting significant indirect effects through worry and fear in each of these instances.

Discussion

In the first stage of the analysis, we found that, through presenting numerical estimates of objective breast cancer risk, the decision intervention lowered PSBC, but this was only true when PSBC was measured as a percentage. On average, women overestimated their breast cancer risk, so a decrease in PSBC brought them closer to estimates of risk calculated using the NCI BCRAT (NCI, 2011). Because risk in the decision aid was presented in a frequency format but the change was seen when measuring risk in a percentage format, this finding may indicate that the intervention had an impact on a participant's gist understanding of susceptibility, rather than their ability to replicate the verbatim details. Drawing on FTT (Reyna, 2008), this is a desirable outcome, because it means that the intervention is more likely to lead to informed decision making than if participants simply recalled and reported the information presented to them verbatim.

We also saw unexpected increases in fear and worry for women in the upper risk stratum who received the decision intervention. This finding is contrary to findings from evaluations of other decision aids and mammography interventions, which often report no increases in

negative emotion (e.g., Mathieu et al., 2007) or even decreases in worry (Hersch et al., 2015). Although women in both risk strata were presented with their estimated breast cancer risk and the risk of an average age-matched comparison woman, women in the upper risk stratum were more likely to have a risk that was higher than that of the comparison woman. Because perceptions of comparative breast cancer risk are correlated with breast cancer worry (Lipkus et al., 2000), seeing that their risks were greater than those of a comparison woman could have heightened generalized worry and fear.

In an effort to understand the mechanism of action of the intervention, the second phase of the analysis tested our hypotheses that PSBC, worry, and fear would mediate the effects of the intervention on mammography intentions. Interestingly, only PSBC as a percentage was a consistent mediator of the effects of the intervention on mammography intentions. For women with a 10-year breast cancer risk > 1.5%, the decision interventions decreased PSBC, and this decrease was related to a decrease in intentions to have a mammogram at age 40. This finding helps explain why, with the exception of one condition, our intervention did not have the expected effects of increasing intentions to begin mammography at age 40 for women in the higher risk stratum; the intended motivating effects of the intervention were likely suppressed by reductions in PSBC. One possible explanation for these reductions is that, because women tend to have an inflated PSBC, the objective estimates seemed low in comparison, and the sense of relief upon learning the accurate number lowered women's intentions to begin mammography at age 40 (an idea adapted from Zikmund-Fisher, Fagerlin, & Ubel, 2010).

Women in the lower risk stratum exhibited a similar pattern of decreased PSBC as a percentage and decreased mammography intentions (i.e., increased intentions to wait until age 50 to get a mammogram). In the *extended intervention + expository* and *extended intervention + untailored exemplars* conditions, the mediation pathway was significant, thus the changes in PSBC contributed to the observed changes in intentions, as predicted. The significant mediation pathways for these conditions (in the absence of significant mediation for other conditions in this risk stratum) may be due to the extra information offered in the extended conditions—these conditions included an additional exposure to one's objective risk estimate and information about how that compared to the risk of an average 50-year-old woman—which produced slightly larger changes in PSBC as a percentage. The pattern of effects was similar in the *extended intervention + tailored exemplars* condition, but a smaller *n* in this condition (a product of randomization to condition) reduced statistical power to find a significant mediation effect.

In contrast, PSBC as a frequency did not significantly mediate the effects of the intervention on mammography intention for women with a 10-year breast cancer risk < 1.5%. This was contrary to our hypothesis and, as mentioned previously, may be indicative of the stronger influence of gist-based understanding (as opposed to recall of precise information) on decision making (Reyna, 2008). These findings also suggest that how PSBC is measured matters when attempting to determine how interventions have their effects. This may be especially true for women with lower numeracy, who are more likely to give differential responses to measures of PSBC based on the measurement scale used (Schapira et al., 2004). As reported in [removed for review], the effect of the intervention on accuracy of perceived

risk was moderated by participant numeracy (i.e., women with lower numeracy were more likely to have inaccurate risk perceptions than women with higher numeracy), so future research should examine how the mechanism of action of risk-based intervention varies depending on the numeracy of the participant.

Finally, despite the heightened worry and fear among women in the upper risk stratum, these increased emotional responses did not translate into changes in intention; emotion mediated the effect of the intervention on mammography intentions in only two cases. Although these findings are in the expected direction and provide limited support for our hypothesis, given the large number of mediation tests conducted and the lack of a consistent pattern of mediation effects, we recommend that readers interpret these two mediation results with caution. Considering that multiple intervention conditions exhibited significant increases in worry and fear for women in the higher risk stratum (Table 3) and that worry and intention were correlated (Table 2), the lack of a stronger mediation effect was surprising. It is possible that the mediation effect was not present because the measures of emotion were generalized measures of worry and fear instead of cancer worry or breast cancer worry, more specifically, as seen in much of the existing literature (e.g., Hay, McCaul, Magnan, 2006). One interpretation of this finding would be that small increases in state worry or fear experienced during decision interventions are not harmful. After all, mean worry and fear scores were still in the lower half of the scale, and the large majority of women in intervention conditions reported intentions to have a mammogram at age 40 (see [reference removed]). In support of this interpretation, Bekker, Legare, Stacey, O'Connor, and Lemyre (2003) argue that an increase in arousal (in their case, anxiety, an emotional state related to worry) is a necessary part of the decision-making process and may even facilitate improved decision making.

Limitations

This research has several limitations, including limitations related to measurement, analytical approach, experimental design, and generalizability. The first limitation is related to our measurement of emotion, as worry and fear experienced while reading the intervention were the only affective states measured, and they were measured using only one item for each construct. Although there is a precedent for using single-item emotion measures in prior research (e.g., Ferrer, Portnoy, & Klein, 2013), single-item measures do not allow for a nuanced distinction between related constructs. Further research may be needed to disentangle the effects of momentary shifts in worry and fear from the effects of cancer worry on mammography intentions. Additionally, other related constructs, such as anxiety and general distress, were not measured. Including these additional constructs would provide further insight into the role of emotion in mediating the effects of decision interventions on screening intentions.

There are also limitations related to our analytical approach and experimental design. Our approach to mediation analysis relies on the assumption that the mediators are measured without error, that there are no omitted (i.e., confounding) variables that explain the relation between the mediators and outcome, and that the mediators are causally prior to the outcome variable. Because the mediators are all single-item measures, reliability is not guaranteed,

and thus mediation effects may be underestimated (Fritz, Kenny, & MacKinnon, 2016). Additionally, if a confounding variable (a variable related to both the mediator and the outcome variable) were omitted, the relation between the mediator and outcome variable could be overestimated (Fritz et al., 2016). Finally, although the experimental design allows us to make causal inferences related to the effects of the decision intervention on constructs measured after the intervention, the design does not allow us to draw conclusions about the order in which other constructs may influence each other. For example, we make the assumption in this research, based on health behaviour theory such as the HBM (Janz & Becker, 1984), that perceived susceptibility is causally prior to intention formation, but it is also possible that participants first formed their mammography intentions and then constructed estimates of susceptibility that were congruent with these intentions. A similar limitation exists in that we cannot examine whether emotion might mediate the effect of the intervention on perceived susceptibility or vice versa. Future research should examine effects of decision interventions longitudinally to determine how they have effects on emotion, perceived susceptibility, and mammography.

There are also limitations on how these findings may generalize to other outcomes, contexts, and settings. First, because the primary outcome measure in this research was mammography intention, results might not generalize to actual mammography behaviour. However, there is evidence that behavioural intention is a strong predictor of behaviour (for a review, see Fishbein & Ajzen, 2010, p. 48), with a meta-analysis of meta-analyses reporting an overall intention–behaviour correlation of .53 (Sheeran, 2002) and another meta-analysis reporting an average correlation of .37 between mammography intentions and behaviour (Cooke & French, 2008). Additionally, because breast cancer is an emotionally charged health topic, findings may not generalize to health contexts other than mammography. Finally, because these findings are drawn from data collected in an online experimental setting with women between the ages of 35 and 49, they may not generalize to in-person contexts or other populations.

Despite these limitations, this research is strengthened by the large, diverse study population and experimental (rather than observational) design. It adds to the literature on how risk perceptions and emotional outcomes mediate changes in behavioural intentions and, thus, has important implications for understanding how mammography decision interventions produce effects.

Implications

Because it provides insight into the interplay between perceived risk, emotion, and mammography decision making, our research has several important implications. First, it provides support that PSBC as a percentage, PSBC as a frequency, and risk-related emotions such as worry and fear are interrelated. Measuring all of these constructs allows one to develop a fuller understanding of the effects of interventions by capturing both cognitive and affective components of perceived risk. This research also provides evidence that perceived susceptibility measured as a percentage may be a more effective measure for explaining effects of interventions than susceptibility measured as a frequency.

This research also has important implications for those developing communication tools, decision aids, or interventions related to mammography. Our findings suggest that interventions can have significant effects on mammography intentions by shaping breast cancer risk perceptions. However, researchers and practitioners should be warned that the presentation of objective breast cancer risk estimates may result in decreases in perceived susceptibility, even among those at higher levels of risk, that can lead to decreased intentions to screen. Additionally, although the emotional aspects of decision making should be considered, this research suggests that increases in worry and fear due to a mammography intervention may not have detrimental effects on behavioural intentions.

Conclusion

Results from an online experiment testing the effects of a personalized risk-based mammography decision intervention demonstrated that the intervention resulted in significant reductions in PSBC as a percentage for both risk strata and significant increases in worry and fear for women in the upper risk stratum. These results also provide insight into the mechanism of action of the intervention. Of the possible mediators examined, only PSBC as a percentage consistently mediated the effect of the intervention on mammography intentions.

Acknowledgments

This work was supported by the Penn Center for Innovation in Personalized Breast Cancer Screening (PCIPS) Population-based Research Optimizing Screening through Personalized Regimens (PROSPR) Grant 1U54CA163313 from the National Cancer Institute. Contents are solely the responsibility of the authors and do not necessarily represent the official views of the National Cancer Institute. The National Cancer Institute was not involved in study design, in the collection, analysis and interpretation of data, in the writing of the report, or in the decision to submit the paper for publication.

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Participant Characteristics

Variable	Comparison: basic info	Conditions						Mean (SD) or average %
		Brief intervention + expository	Brief intervention + untailored exemplars	Brief intervention + tailored exemplars	Extended intervention + expository	Extended intervention + untailored exemplars	Extended intervention + tailored exemplars	
Participants with an estimated 10-year breast cancer risk < 1.5%								
<i>n</i>	150	141	169	121	160	154	138	
Mean age (<i>SD</i>)	38.8 (3.2)	38.7 (3.5)	39.0 (3.6)	39.1 (3.9)	38.8 (3.5)	38.8 (3.4)	38.8 (3.6)	38.9 (0.10)
10-year breast cancer risk, <i>M</i> (<i>SD</i>)	1.08 (0.23)	1.07 (0.25)	1.10 (0.24)	1.07 (0.25)	1.07 (0.24)	1.09 (0.24)	1.06 (0.24)	1.08 (0.01)
Race:								
% White ^{<i>a</i>}	69.3	73.1	66.9	67.8	66.9	65.6	74.6	69.0
% African American	9.3	7.8	13.6	14.9	13.1	14.3	7.3	11.5
Education:								
% HS ^{<i>b</i>}	17.3	24.8	17.2	24.0	16.9	19.5	26.8	20.1
% Some college	40.0	29.1	37.9	38.8	37.5	39.6	41.3	37.7
% College+	41.3	41.1	43.8	33.9	42.5	37.7	31.2	40.0
% Have insurance	80.0	78.0	78.7	80.2	84.4	77.3	77.5	79.9
% Had prior mammogram	43.3	36.2	42.6	40.5	38.8	39.6	35.5	40.0

	Participants with an estimated 10-year breast cancer risk $\geq 1.5\%$					
n	196	210	195	200	212	214
Mean age (SD)	44.4 (3.5)	43.7 (3.8)	43.6 (3.8)	44.1 (3.8)	44.1 (3.9)	44.0 (4.1)
10-year breast cancer risk, M	2.68 (2.03)	2.54 (1.31)	2.51 (1.37)	2.45 (1.23)	2.58 (1.34)	2.30 (0.91)
					2.73 (1.88)	2.53 (0.04)

Variable	Conditions							Mean (SD) or average %
	Comparison: basic info	Brief intervention + expository	Brief intervention + untailored exemplars	Brief intervention + tailored exemplars	Extended intervention + expository	Extended intervention + untailored exemplars	Extended intervention + tailored exemplars	
% HS ^b	15.8	18.6	18.5	20.1	21.7	16.1	15.0	17.9
% Some college	39.8	31.4	38.0	34.2	35.9	31.2	36.5	36.2
% College+	42.4	48.1	43.1	43.7	40.1	51.7	46.7	44.1
% Have insurance	83.7	85.2	82.6	77.0	76.9	83.4	85.1	82.7
% Had prior mammogram ^c	79.1	78.1	67.7	68.0	74.1	78.1	77.1	74.1

Note. $N = 2465$. '10-year breast cancer risk' refers to the risk for developing breast cancer in the next 10 years as estimated by the National Cancer Institute (NCI) Breast Cancer Risk Assessment Tool (BCRAT) (National Cancer Institute, 2011).

^aThe omitted race/ethnicity category is 'other.'

^bThe omitted education category is 'less than high school.' HS is an abbreviation for high school.

^cHistory of prior mammograms varied significantly across conditions for women with a 10-year breast cancer risk 1.5%.

Correlation between Mammography Intention, Perceived Susceptibility to Breast Cancer (PSBC), Worry, and Fear, by Risk Stratum

Table 2

Participants with an estimated 10-year breast cancer risk < 1.5% (<i>n</i> = 1,033)						
	Intends to wait until age 50 to have mammogram	PSBC as %	PSBC as frequency	Worry	Fear	<i>M</i> (<i>SD</i>)
Intends to wait until age 50 to have mammogram	1.00					0.17 (0.38)
PSBC as %	-0.15 ***	1.00				15.88 (18.38)
PSBC as frequency	-0.09 **	0.29 ***	1.00			103.40 (233.71)
Worry	-0.11 ***	0.21 ***	0.02	1.00		2.38 (1.23)
Fear	-0.10 ***	0.19 ***	0.02	0.84 ***	1.00	2.18 (1.22)
Participants with an estimated 10-year breast cancer risk 1.5% (<i>n</i> = 1,432)						
	Intends to wait until age 50 to have mammogram in 40s	PSBC as %	PSBC as frequency	Worry	Fear	<i>M</i> (<i>SD</i>)
Intends to wait until age 50 to have mammogram in 40s	1.00					0.74 (0.44)
PSBC as %	0.14 ***	1.00				18.34 (19.32)
PSBC as frequency	0.03	0.33 ***	1.00			124.03 (241.50)
Worry	0.08 **	0.21 ***	0.04	1.00		2.32 (1.23)
Fear	0.09 ***	0.21 ***	0.05	0.85 ***	1.00	2.13 (1.20)

p < .001**
p < .01*
p < .05

Table 3
Perceived Susceptibility to Breast Cancer (PSBC), Worry, and Fear, by Experimental Condition

	Experimental Condition						<i>F</i> (<i>df</i>)
	Comparison: basic info	Brief intervention + expository	Brief intervention + untailored exemplars	Brief intervention + tailored exemplars	Extended intervention + expository	Extended intervention + untailored exemplars	
Participants with an estimated 10-year breast cancer risk < 1.5%							
<i>n</i>	150	141	169	121	160	154	138
PSBC as %, <i>M</i> (<i>SD</i>)	21.2 (19.4)	17.7 (20.7)	13.8 (17.0)	14.9 (17.5)	15.8 (19.2)	14.9 (17.3)	12.8 (16.1)
Beta		−0.064	−0.148 ***	−0.110 **	−0.106 *	−0.121 **	−0.155 ***
PSBC as frequency, <i>M</i> (<i>SD</i>)	115.5 (182.2)	128.2 (261.8)	85.9 (210.9)	163.8 (321.7)	108.4 (245.1)	40.0 (143.4)	98.3 (241.7)
Beta		0.019	−0.047	0.067	−0.011	−0.115 **	−0.025
Worry, <i>M</i> (<i>SD</i>)	2.21 (1.20)	2.45 (1.23)	2.28 (1.27)	2.40 (1.18)	2.44 (1.25)	2.56 (1.22)	2.33 (1.26)
Beta		0.064	0.019	0.048	0.068	0.102 *	0.033
Fear, <i>M</i> (<i>SD</i>)	2.10 (1.19)	2.18 (1.24)	2.09 (1.18)	2.20 (1.19)	2.17 (1.17)	2.36 (1.27)	2.19 (1.30)
Beta		0.022	−0.003	0.026	0.020	0.077	0.025
Participants with an estimated 10-year breast cancer risk 1.5%							
<i>n</i>	196	210	195	200	212	205	214
PSBC as %, <i>M</i> (<i>SD</i>)	25.9 (23.2)	18.3 (18.6)	18.5 (19.2)	16.5 (17.6)	16.8 (18.6)	16.6 (18.6)	16.2 (17.8)
Beta		−0.140 ***	−0.131 ***	−0.170 ***	−0.167 ***	−0.169 ***	−0.181 ***
PSBC as frequency, <i>M</i> (<i>SD</i>)	133.2 (198.7)	134.1 (246.4)	141.0 (253.7)	133.5 (253.7)	121.7 (259.5)	104.5 (239.0)	102.3 (233.3)
Beta		0.001	0.011	0.000	−0.017	−0.042	−0.046
Worry, <i>M</i> (<i>SD</i>)	2.05 (1.81)	2.43 (1.24)	2.43 (1.31)	2.37 (1.24)	2.32 (1.16)	2.32 (1.23)	2.30 (1.24)
Beta		0.108 **	0.103 **	0.089 *	0.076 *	0.074 *	0.069 *
							2.11 (6, 1422) *

	Experimental Condition						<i>F</i> (<i>df</i>)
	Comparison: basic info	Brief intervention + expository	Brief intervention + untailored exemplars	Brief intervention + tailored exemplars	Extended intervention + expository	Extended intervention + untailored exemplars	Extended intervention + tailored exemplars
Fear, <i>M</i> (<i>SD</i>)	1.90 (1.11)	2.20 (1.18)	2.32 (1.29)	2.11 (1.21)	2.19 (1.15)	2.14 (1.23)	2.33 (6, 1422) *
Beta		0.086 *	0.119 **	0.060	0.085 *	0.070 *	0.044

Note. *N* = 2465. Analyses use OLS regression to regress PSBC as %, PSBC as frequency, worry, or fear on condition (each intervention condition compared to *basic info*. PSBC as a percentage was measured by asking participants the following: ‘What is your chance of developing breast cancer in the next 10 years?’ Please choose a number between 0% (no chance of breast cancer) and 100% (I definitely will get breast cancer).’ Participants were also asked to estimate their PSBC using a frequency format: ‘What is your chance of developing breast cancer in the next 10 years?’ _____ out of 1000.’ Worry was measured by asking participants how much the word ‘worried’ described how they ‘felt while reading the decision aid’ on a five-point scale from 1 (*not at all*) to 5 (*very much*). Fear was measured on the same scale by asking participants how much the word ‘afraid’ described how they felt while reading the decision aid. The *F*-test is an overall test for each regression. *M* = mean. *SD* = standard deviation. The Beta reported is the standardized regression coefficient associated with each condition compared to the ‘Comparison: basic info’ condition.

p < .001
**
p < .01
*
p < .05

Table 4

PSBC as % as a Mediator of the Effect of the Intervention on Intention to Have Mammograms in One's 40s, 10-Year Risk 1.5%

Model paths	Constant, Coeff. (SE)	Path α : Effect of X (condition) on M (PSBC as %), Coeff. (SE)	Path b : Effect of M (PSBC as %) on Y (intention), Coeff. (SE)	Path c' : Effect of X (condition) on Y (intention) controlling for M (PSBC as %), Coeff. (SE)	R^2 or pseudo R^2	$F(df), p$ or $\chi^2(df, n), p$	Indirect effect of X on Y through M, Coeff. (bootstrapped bias-corrected 95% CI)
Brief intervention + expository $\rightarrow$ PSBC as %	25.93 (1.51) ***	-7.60 (2.09) ***	—	—	0.03	13.27 (1, 400) ***	—
PSBC as % $\rightarrow$ intention; Brief intervention + expository $\rightarrow$ intention	0.32 (0.21)	—	0.028 (0.007) ***	0.41 (0.24)	0.05	21.07 (2, 402) ***	-0.06 (-0.10, -0.02)
Brief intervention + untailored exemplars $\rightarrow$ PSBC as %	25.93 (1.54) ***	-7.39 (2.17) **	—	—	0.03	11.64 (1, 384) ***	—
PSBC as % $\rightarrow$ intention; Brief intervention + untailored exemplars $\rightarrow$ intention	0.31 (0.21)	—	0.029 (0.007) ***	0.52 (0.25) *	0.05	22.13 (2, 386) ***	-0.06 (-0.11, -0.02)
Brief intervention + untailored exemplars $\rightarrow$ PSBC as %	25.93 (1.48) ***	-9.46 (2.07) ***	—	—	0.05	20.75 (1, 388) ***	—
PSBC as % $\rightarrow$ intention; Brief intervention + untailored exemplars $\rightarrow$ intention	0.43 (0.21)	—	0.023 (0.006) ***	0.082 (0.233)	0.03	14.83 (2, 390) ***	-0.06 (-0.11, -0.03)
Extended intervention + expository $\rightarrow$ PSBC as %	25.93 (1.51) ***	-9.10 (2.09) ***	—	—	0.05	19.04 (1, 401)	—
PSBC as % $\rightarrow$ intention; Extended intervention + expository $\rightarrow$ intention	0.41 (0.21)	—	0.024 (0.007) ***	0.38 (0.24)	0.03	16.08 (2, 403)	-0.06 (-0.11, -0.02)
Extended intervention + untailored exemplars $\rightarrow$ fear	25.93 (1.51) ***	-9.29 (2.10) ***	—	—	0.05	19.51 (1, 394)	—
PSBC as % $\rightarrow$ intention; Extended intervention + untailored exemplars $\rightarrow$ intention	0.43 (0.21)	—	0.023 (0.006) **	0.38 (0.24)	0.03	14.50 (2, 396) ***	-0.06 (-0.11, -0.02)
Extended intervention + tailored exemplars $\rightarrow$ PSBC as %	25.93 (1.48) ***	-9.78 (2.04) ***	—	—	0.05	22.94 (1, 403)	—
PSBC as % $\rightarrow$ intention; Extended intervention + tailored exemplars $\rightarrow$ intention	0.50 (0.21) *	—	0.020 (0.006) **	-0.017 (0.23)	0.02	11.98 (2, 405)	-0.05 (-0.10, -0.02)

Note. This table displays the results of regression analyses examining the role of PSBC as a percentage (PSBC as %) as a mediator of the relationship between condition and intention to have mammograms in one's 40s for women with an objectively estimated 10-year breast cancer risk 1.5%. X, M, and Y refer to the independent variable, the mediator, and the outcome variable, respectively. Paths a, b, and c' refer to the paths between X and M, M and Y, and X and Y controlling for M, respectively. Each condition is compared to the *Comparison: Basic info* condition. PSBC as % is the participant's perceived

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susceptibility to breast cancer (their self-reported likelihood of being diagnosed with breast cancer in the next 10 years), measured as a percentage. To measure mammography intentions, participants were asked to select the statement that best described their mammography intentions: 'I will start or continue to have mammograms in my 40s', 'I will have my first or next mammogram at age 50', 'I will never have a mammogram', or 'I am undecided.' For women with an estimated 10-year risk of 1.5% or higher, 'I will start or continue to have mammograms in my 40s' was recoded as 1 and all other responses were recoded as 0. The indirect effect of X on Y through M is calculated by standardizing paths *a* and *b* to account for differences in scaling due to the combination of logistic and OLS regression and then multiplying these two paths. The confidence interval for the indirect effect is the bias-corrected 95% confidence interval based on 10,000 bootstraps. If the confidence interval for the indirect effect does not include zero, there is evidence of mediation; these instances appear in boldface type.

p > .001
**
p < .01
*
p < .05