A COMMUNICATION SCIENCE EVALUATION OF BREAST DENSITY NOTIFICATION LETTERS: BREAST CANCER RISK PERCEPTIONS AND PRECAUTION MOTIVATION

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ABSTRACT

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This dissertation explores women's understanding of breast density, as well as relevant risk perceptions and motivation to enact a precautionary behavior (e.g., talking to their health care provider about breast density) after reading a breast density message. The latter is accomplished with a common risk message design framework, the extended parallel process model (EPPM), which is then expanded given recent theorizing in other risk perception literature around more specific construct operationalization and the inclusion of affect-laden judgements. To test this change and to evaluate the potential outcome of reading a breast density notification letter, two studies are described. First, a quasi-experiment compares women likely to receive breast density notification letters (i.e., aged 40 to 50 years) in states with versus without breast density notification legislation on breast density knowledge and motivational outcomes. Then, in a second study, a similar sample of women read a hypothetical breast density notification letter and reported relevant risk perceptions and intention to talk with their health care provider about their breast density. Results indicated no differences in knowledge and motivational outcomes between women in states with versus without legislation mandating breast density notification letters. Results did, however, suggest breast density notification letters might affect women's risk perceptions, represented as a potential mix of affective and deliberative dimensions. These data suggest more precise operationalization of EPPM constructs in experimental contexts is required, as well as continued applied research in the realm of breast density. As such, implications for breast density research and EPPM theorizing are discussed in light of these findings, with discussion of future research and informational needs.

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CHAPTER 1

Introduction

One in eight women are diagnosed with breast cancer at some point in their life, with an expected 331,5300 new cases in 2019 (American Cancer Society, 2019). Breast cancer is the second most diagnosed cancer in U.S. women and is second only to skin cancers in cancer-related deaths. Fortunately, U.S. women tend to be aware of breast cancer and largely recognize regular screening via mammography can detect breast cancers early enough to be treated (Health Information National Trends Survey, 2006). There is also a large amount of research conducted to date addressing a variety of psychosocial states and their relation to cognitions about and outcomes related to breast cancer, including the relation of worry about breast cancer to women's intention to be screened for cancer (e.g., Hay, McCaul, & Magnan, 2006), and how women's perceptions of their provider's communication predicts whether they pursue screening (e.g., Totzkay, Silk, & Sheff, 2017). Communication research has demonstrated a large emphasis in the media on being screened to detect breast cancer early (Atkin, Smith, McFeters, & Ferguson, 2008).

While mammography remains the best option to screen for breast cancer (American College of Radiology, 2018a), the ability to detect tumors can be diminished by the density of a woman's breast tissue. Breast density, or dense breast tissue, refers to the proportion of fibro-glandular breast tissue to breast fat (Wang, et al., 2014). Denser tissue appears white on mammograms, as do tumors, and therefore complicates tumor detection. There is also growing evidence suggesting breast density is associated with increased cancer risk, apart from its masking of mammograms (Boyd et al., 2018).

To further complicate matters, 35 states so far have passed legislation requiring a woman's mammogram report communicate her breast density (Densebreast-info.org). These

breast density notification letters are meant to increase a woman's knowledge of breast density and to encourage conversation about density with her health care provider (Dehkordy & Carlos, 2013). These letters are thus intended to educate women and promote shared decision-making. However, critics claim breast density notifications cause unneeded anxiety, overly infringe upon medical practice, and potentially limit attention to more pertinent risk factors (Haas & Kaplan, 2015; Klinger, Kaplan, St. Hubert, Birdwell, & Haas, 2016; Rey, Price, & Joe, 2015).

Despite both praise and concerns, there are scant data on women's perceptions of and reactions to breast density notification letters. The few existing studies need to be extended and have been limited by a lack of theory-guided study designs. Luckily, communication science is well-equipped to evaluate the potential psychological and behavioral consequences of breast density notification legislation. Frameworks like the extended parallel process model (EPPM) and other closely-related risk perception theories that examine one's cognitive appraisals of a potential threat after receiving a risk message are particularly fit for application in this context (Maloney, Lapinski, & Witte, 2011). With a focus on what cognitions are necessary for the adoption of precautionary behavior, like discussing breast density with one's health care provider, paradigms used in health and risk communication like the EPPM can examine whether breast density notifications are achieving their goals or create potentially maladaptive responses.

This dissertation has three goals. The first is to fill a gap in understanding of breast density notification letters' impact by examining whether they have resulted in measurable differences in affected states. The second is to expand on this by gauging women's reactions to a notification letter via a number of recognized dimensions of risk perception. Finally, the third goal is to make distinct several risk perception constructs (e.g., feeling vulnerable, perceived likelihood, worry) often conflated in risk perception research and explore their differential impact on behavioral intention. To accomplish these goals, this dissertation first reviews research

on breast density. Then, the EPPM and related research is discussed for application to the communication of breast density information. Within this, distinctions are made across several risk perception dimensions often confused in research, especially in the limited social research regarding breast density, in order to inspire their wider application in communication research and theorizing. Finally, two studies are detailed that measure women's knowledge of breast density and, following exposure to a sample breast density notification, breast cancer and breast density risk perceptions.

CHAPTER 2

Breast Density

Breast density refers to the extent breast tissue is dense versus fatty. A woman's breast tissue is made mainly of fat and fibro-glandular tissue, with the latter being a mixture of fibrous stroma and epithelial cells that line breast ducts (see Chen, Gulson, & Su, 2015). Breasts are considered "dense" when there is a greater proportion of this tissue, which can reflect X-rays and thus appear white on mammograms, to fat (Wang, Vachon, Brandt, & Ghosh, 2014). This *radiopaque* attribute of dense breast tissue complicates the identification of breast abnormalities, which also appear white on mammograms. Breast density, however, is not related to any physically observable outcome, such as what could be observed in a physical exam (see Freer, 2015) and is thus an *imaging* outcome and not a clinical one (Smith, 2013).

Breast density is measured by radiologists using the four-category Breast Imaging and Data Systems (BI-RADS) scale (Carney et al., 2003). These categories include "mostly fatty" breasts, "scattered fibro-glandular" breast tissue, "heterogeneously dense" breast tissue, and "extremely dense" breast tissue (American Cancer Society, 2018a). Approximately half of women between the ages of 40 and 74 years are estimated to have either heterogeneously or extremely dense breasts (Sprague et al., 2014; Wang et al., 2014). This corresponds to approximately 27.6 million U.S. women. Additionally, most women who fall into the category of *extremely dense breasts* are between the ages of 40 and 49 years.

Breast density as a concept was originally intended only for radiologists to characterize mammogram results and record their uncertainty regarding whether cancer was present (Gard, Aiello Bowles, Miglioretti, Taplin, & Rutter, 2015). This information was primarily used by and communicated among radiologists, and perhaps a woman's health care provider, but was never widely circulated otherwise especially because it is subjective and not necessarily useful to

patients. Density assignment is subjective, in that it is determined by the radiologist interpreting the mammogram. This radiologist judges if the approximate proportion of "dense" fibro-glandular tissue, which is white on a mammogram, is larger or smaller than the approximate proportion of fat. This may not be a reliable judgment, though, with some research finding inconsistent ratings over time and across radiologists (Gard et al., 2015; Gur, Klym, King, Bandos, & Sumkin, 2015).

Breast Density and Breast Cancer Risk

What has been described thus far regarding breast density is a "masking effect," which is construed as increasing a woman's breast cancer risk since cancer detection is more difficult. There is a growing body of evidence, however, suggesting breast density increases breast cancer risk independent of its masking effect. Theorizing around this increased risk posits the greater degree of tissue proliferation and the larger number of epithelial cells (as there is more epithelial tissue than for less dense breast tissue) also increases a woman's risk of developing breast cancer (Boyd et al., 2018). This increase in risk is because there are more cells dividing and changing rapidly, thus becoming susceptible to potentially cancerous mutation. Additionally, the exact degree of risk breast density represents is under debate (Freer, 2015), but the *relative* risk of breast density is viewed as smaller than other major risk factors like age, family breast cancer history, or genetic makeup. Yet, some forward that due to breast density's masking of tumors on a mammogram, it presents a much greater danger to the general public (see Boyd, Martin, Yaffe, & Minkin, 2011). Regardless of the exact mechanism and despite recognition of breast density as a risk factor for breast cancer (Harvey & Bovbjerg, 2004), women are likely not aware of their own breast density (Guterbock et al., 2017) nor of the implications of it for their cancer risk.

Limited breast density knowledge may not be surprising as density information has not traditionally been routinely communicated to patients (Colin & Schott, 2011; Vachon et al.,

2007). This lack of communication, though, is primarily attributed to a lack of knowledge among health care providers themselves (Mirghani, Goldber, Jaspen, Copit, & Scavin, 2017), as well as a great deal of uncertainty regarding the exact risk attributed to breast density and how it weighs against other more well-known and understood risks, like family history and the presence of the BRCA1 or BRCA2 genes (Haas & Kaplan, 2015). Nevertheless, breast cancer advocates have pushed for more information to be made available about breast density and for the communication of that information to be required when a woman has a mammogram.

Breast Density Awareness and Notification

To date, several cross-sectional studies have found women of recommended screening age (i.e., 40 years and older) generally do not know their breast density nor the implications of breast density for cancer risk (Manning, Albrecht, Yilmaz-Saab, Penner, Norman, & Purrington, 2017; Manning, Duric, Littrup, Bey-Knight, Penner, & Albrecht, 2013; O'Neill, Leventhal, Scarles, Evans, Makariou, Pien, & Willey, 2014; Rhodes, Breitkopf, Ziegenfuss, Jenkins, & Vachon, 2015; Trinh et al., 2015; Totzkay, Thomas et al., 2018). Under normal circumstances, limited public understanding of an already little-known medical term would not be surprising. However, breast density has been propelled into public attention after a woman named Nancy Cappello received a mammogram report claiming to have not found cancer, only to be diagnosed with an aggressive breast cancer three months later (Are You Dense?, Inc., 2018). After recovering, Cappello spearheaded a movement to increase public understanding of breast density and its effect on mammogram sensitivity, as well as to promote additional screening.

Activism lead by Cappello and others resulted in Connecticut in 2009, being the first state to mandate the notification of breast density to women who undergo mammography (Slanetz, Freer & Birdwell, 2015). At the time of this writing, 35 states have passed similar legislation, which typically mandates specific language be included in a mammogram lay report.

This language tells a woman whether or not she has dense breasts and suggests she speak with her health care provider about what this means for her, as well as what supplemental cancer screening options are available (DenseBreast-info, 2018b). Of note, only a small number of these state laws provide additional provisions mandating insurance coverage for supplemental screening, potentially leaving most women without such coverage if supplemental screening is pursued (see Freer et al., 2015).

Breast density notification laws were passed to increase women's of mammography's limitations (Molleran, 2014), especially because mammographic sensitivity drops by up to half for women with dense breasts (see Butler, 2015). As mentioned previously, goals of this legislation also include encouraging a dialogue between a woman and her health care provider regarding what her breast density means for her overall health, as well as exploring additional, supplemental cancer screens like whole-breast ultrasonography, magnetic resonance imaging, and digital breast tomosynthesis (Molleran, 2014; O'Neill et al., 2014). However, the American College of Radiology (see Molleran, 2014) and the American College of Obstetrics and Gynecologists (Committee on Gynecological Practice, 2015) continue to recommend only women who are at particularly high risk for breast cancer undergo supplemental screening. These screening approaches tend to be less conservative than mammography, making them more likely to detect non-cancerous breast abnormalities (Freer, 2015) and thus increasing the possibility of unnecessary care.

The notion that a woman knowing her breast anatomy (i.e., the density of her breasts) will better position her to make informed decisions about her health care and whether to undergo additional cancer screening fits squarely within the scope of the U.S. health care system's ongoing focus on shared decision making (Jones & Stevens, 2014). However, some data indicate receiving a dense breast notification letter might lead women to believe something is wrong,

perhaps even that cancer is present, even though this is not stated in the notification itself (Gunn, Bataglia et al., 2018). This could cause anxiety and lead women to make suboptimal decisions about their care. Indeed, health care providers and public health researchers question mandating these notifications, claiming there is no evidence that extra screening is warranted simply due to breasts being dense (Rey, Price, & Joe, 2014). These laws are also viewed as having created an unsubstantiated idea that additional screening outside of the mammogram is intrinsically better for all women (Haas & Kaplan, 2015). Speculation or anecdotal accounts have come primarily from skeptical medical professionals, as has also been the case for supporters of the legislation. The picture is much less clear when it comes to empirical evidence on the experiences and reactions of women who have been notified that they have dense breasts.

Women's Understanding of Breast Density

As noted previously, many women do not know their own breast density, nor even what breast density is, in general. Breast density notifications, then, seem like they should close the clear gap that exists in women's breast density knowledge. However, evidence collected to date suggests otherwise; few data suggest these laws succeed in improving women's understanding of their breast cancer risk, the limitations of mammography, and the proper selection of supplemental screening (Haas & Kaplan, 2015). In fact, only a handful of studies exist that even measure women's perceptions of breast density and breast cancer after receiving a breast density notification letter. Not only that, but the notification letters themselves have been found to be at very high reading levels (e.g., Flesch-Kinkaid = grade 19.4 reading level for Connecticut's letter) and otherwise rate poorly on patient accessibility measures (Kressin, Gunn, & Battaglia, 2016).

A number of studies have attempted to assess women's perceptions of breast density and breast density notification letters. Qualitative studies have found women recruited from medical centers post-mammogram recall being told they have dense breasts, but struggle to

define what that means or its implications (e.g., Gunn, Bataglia et al., 2018). In fact, some women believe having dense breasts indicates something is wrong and could even mean they have cancer, with others report feeling anxious and in danger. Another study that recruited women through community mechanisms found similar results, along with general uncertainty and misunderstanding (Totzkay, Thomas et al., 2018). Quantitative studies also find just a slight majority of women are aware of breast density and, when told their own density, intend to speak with their health care provider about it (Manning et al., 2017; Miles, Lehman, Warner, Tuttle, & Saksena, 2018; O'Neill et al., 2014; Yeh, Schnur, Margolies, & Montgomery, 2015). These studies find some associations between the intention to speak with a health care provider and both perceived risk likelihood and anxiety about breast density. These findings suggest breast density notification letters are in part achieving their goals of educating women about breast density and motivating conversation with the health care providers.

These past studies regarding breast density understanding, however, have a number of limitations that prevent a more robust understanding of how women react to breast density notification letters. Most rely only on women's recollection of the breast density notification letter they received some time in the past and primarily rely on a single region which already has breast density legislation to sample women from. These studies further tend to rely on single-item measurements for risk perception constructs that preclude validity assessments, seldom use inferential statistics, and only two studies appear to derive hypotheses from theory (i.e., Manning et al., 2017; Yeh et al., 2015).

A necessary next step is an analysis of women from multiple regions in the U.S., including those without legislation passed, along with and explication of potential cognitive and affective mechanisms that may drive women's clinical decisions regarding breast density. Before that, however, exactly what is learned from breast density notification letters needs to be

examined. When assessing awareness of breast density and its associated cancer risk, past studies tend to use leading questions ("Does having dense breasts increase breast cancer risk?") or otherwise close-ended, yes-no questions that could lead participants to make a judgment of "awareness" despite not actually comprehending the information presented to them. This prompted recall likely skews reports of awareness to appear much higher than they actually are (Weinstein, 1999). It might even be that awareness is *more prevalent* than is reported, in that women may have intuitive lay theories about what breast density is and how it may impact breast cancer risk (Totzkay, Thomas et al., 2018). However, a past study that reported women being familiar with the term "breast density" found that those same women could not offer any concrete details on what breast density actually meant (Gunn, Bataglia et al., 2018). This indicates breast density notifications are may not be achieving their patient education goals, though more data of this nature is required to make a definitive statement to this effect. However, such a conclusion cannot be drawn since, as noted, these studies draw samples exclusively from states with mandated breast density notification.

Given the lack of inclusion of states without mandated breast density notification, data are therefore needed that not only measure women's breast density perceptions in states that do not have mandated educational activities, but also data assessing if this is significantly and substantially different from the perceptions of women in states that do have mandated breast density education. As such, this dissertation first explores whether women in states with legislation have more accurate knowledge about breast density than women in states without legislation. The expectation would be that for women in states with legislation, breast density knowledge should be more accurate than for women in states without legislation. It should also be that women, in general, should have more accurate breast density knowledge immediately

following their reading of a breast density notification letter. However, it is not known if women in these different states will respond to a breast density notification letter.

H1: *Women in states with a breast density notification letter mandates will have more accurate breast density knowledge than similar women in states without a breast density notification letter mandate.*

H2: *Women who have read a breast density notification letter will have accurate breast density knowledge.*

RQ1: *After reading a breast density notification letter, how will women's responses differ based on whether they are from a state with versus without breast density notification legislation?*

This dissertation then measures whether women across these states vary in their intention to talk with their health care provider about breast density, as motivating this conversation is a goal of the legislation. According to prominent health and risk behavior change theories, including the health belief model (Rosenstock, 1974), protection motivation theory (Rogers, 1975), and the later-discussed EPPM, central to the prediction of one's intention are assessments of response efficacy and self-efficacy. Response efficacy refers to the belief that an action recommended by a risk message is effective in mitigating the harm the referent risk presents (Maloney, Lapinski, & Witte, 2011). Self-efficacy, on the other hand, refers to one's confidence in their ability to enact that behavior which is perceived to be effective in reducing risk. What breast density notifications are attempting to do, then, is increase women's perceptions of response and self-efficacy for talking about their breast density with their health care providers. As noted above, these notifications are meant to encourage dialogue between a woman and her health care provider by introducing the concept of breast density and showing that it is important for her health care decision-making (Jones & Stevens, 2014). So, if breast density notifications are in fact succeeding in their goals, it should be that women who are likely to have received a

notification, compared to those who are not, have greater self-efficacy and response efficacy regarding their communication with health care providers about breast density, and, because of that, have a greater intention to do so.

H3: *Compared to similar women in states with a breast density notification letter mandate, women in states without a breast density notification letter mandate a) have greater intention to talk with their health care provider about their breast density, b) perceive greater self-efficacy for talking with their health care provider about their breast density, and c) perceive greater response efficacy for talking with their health care provider about breast density.*

H4: *Women's intention to talk with the health care provider about their breast density is predicted by a) self-efficacy and b) response efficacy for talking with one's health care provider.*

Breast Density Summary

In summary, breast density is a visual classification made by radiologists when viewing a woman's mammogram. This classification is based on the level of dense tissue, which appears white on a mammogram, compared to the level of fat in a breast. Breasts with a greater amount of dense breast tissue pose a challenge for interpreting mammograms because dense breast tissue can either look the same as a tumor or obscure the radiologist's view of a tumor. There has been recent legislative effort and success in mandating that a letter with breast density information be sent to women with the results of their mammogram, which has the potential to increase confusion and anxiety around breast cancer and mammography.

It is not well-understood, however, whether breast density legislation succeeds in its goals of patient education and motivating conversations between women and their health care providers. Self-report studies of women's breast cancer risk perceptions after receiving breast density notifications are, at the time, limited and subject to several methodological flaws that prevent generalizableability of findings. Namely, past studies only sample from states with

existing breast density legislation and do not measure if there are substantive differences between states with and without such legislation regarding education and motivation. To address these concerns, this dissertation examines whether women in states with a breast density notification letter mandate, compared with women in states without such a mandate, have more accurate breast density knowledge, a greater intention to talk with their health care provider about their breast density, and perceive more self-efficacy and response efficacy about talking with their health care provider. In addition, it is expected that women will be accurate in their breast density knowledge, intend to talk with their health care provider, and feel efficacious about doing so after reading a breast density notification letter, regardless of legislation status.

CHAPTER 3

Risk Perception and the Extended Parallel Process Model

As briefly discussed, breast density notifications target not only women's awareness, but also their motivation to talk with their health care provider while also potentially influencing cancer-related concerns and faith in using mammography as a cancer screen (Gunn, Bataglia et al., 2018; Manning et al., 2017; Yeh et al., 2015). Fortunately, this constellation of perceptions can easily be accounted for by prominent theoretical paradigms studying the role of risk perception on precautionary behavior. Specifically, a number of expectancy-value theories collect self-report data on deliberative risk perceptions, like the perceived severity and susceptibility of a risk, and subsequent and/or intended risk-related behavior (e.g., Ajzen & Fishbein, 2005; Rogers, 1975; Rosenstock, 1974; Weinstein, 1999; Witte, 1992). These theories largely predict that assessments of risk likelihood and seriousness must be sufficiently elevated in order for an individual to take some protective, precautionary behavior like talking with their health care provider about their breast density.

The Extended Parallel Process Model

One prominent and well-tested theory focused on the connection between risk perception and precautionary, risk-reducing behavior is the EPPM (Witte, 1992). The EPPM posits that a risk message promotes a risk-reducing precautionary behavior via a process involving one's perception of threat and efficacy. Specifically, the EPPM suggests precautionary behavior will only be motivated by a message if the message recipient perceives the risk to be serious and likely to affect them. When a message leads to an appraisal of a risk being sufficiently threatening, an individual will experience negative affect like fear or worry about the risk.

Importantly, though, the EPPM posits that a recommended risk reduction behavior will only be enacted if the risk message recommends a risk-reducing behavior and leads an individual

to perceive something can be done about the threat and that they are capable of doing so (Maloney, Lapinski, & Witte, 2011). Without sufficient perceptions of efficacy, which was briefly discussed in the preceding section, the EPPM predicts a *fear control* process wherein cognitive appraisals are made to reduce the perceived threat presented in the risk message. This includes minimizing a message, derogating the source of the message, or acting opposite to the message's recommendation (Witte, 1992). However, if sufficient efficacy is felt, the EPPM predicts a *danger control* process wherein the message recipient will evaluate a message and its recommended action favorably, will intend to enact the message's recommended behavior, and be more likely to actually enact said behavior. In other words, the EPPM posits that persuasion is facilitated by a combination of threat and efficacy, but is resisted otherwise.

EPPM and Threat Appraisal

The perception of threat in the EPPM is known as the *threat appraisal* and consists of two dimensions: perceived severity and perceived susceptibility. *Perceived severity* is the extent an individual believes a risk is not just hazardous, but has serious consequences for their life (Janssen, van Osch, de Vries, & Lechner, 2011; Maloney, Lapinski, & Witte, 2011; Weinstein, 1999). *Perceived susceptibility*, on the other hand, is the extent an individual believes they are likely to experience a risk and its consequence. These two constructs are combined under the umbrella of *perceived threat* in the EPPM, a perception required for behavior to be motivated.

Application of perceived severity, susceptibility, and threat, however, is inconsistent. While the EPPM clearly treats perceived threat as being constructed by the distinct constructs of perceived severity and perceived susceptibility, most applications of the EPPM simply sum or average these variables together into a single index of threat (see Papova, 2012; e.g., Quick, LaVoie, Reynolds-Tylus, Martinez-Gonzales, & Skurka, 2018). However, these perceptions have been shown to be psychometrically distinct (El-Toukhy, 2015; Portnoy, Ferrer, Bergman, &

Klein, 2014). Indeed, experiments and meta-analyses consistently show both of these risk perceptions separately influence both behavioral intention and future behavior (Brewer, Chapman, Gibbons, Gerrard, McCaul, & Weinstein, 2007; Sheeran, Harris, & Epton, 2013; Shiloh, Wade, Roberts, Alford, & Biesedar, 2013; Brewer, Weinstein, Cuite, & Herrington, 2004; Weinstein, 2007). Therefore, it should be that the distinct constructs of perceived severity and perceived susceptibility predict the intention to enact risk-reduction behavior.

EPPM and Coping Appraisal

As noted, the EPPM posits a *coping appraisal* is also induced by a risk message to motivate precautionary behavior (Witte, 1992). Here, the coping appraisal involves an assessment of response efficacy and self-efficacy, which were both introduced previously. Again, response efficacy, derived from frameworks like the health belief model (Rosenstock, 1974) and protection motivation theory (Rogers, 1975), refers to the belief that an action recommended by a risk message is effective in mitigating the harm the referent risk presents (Maloney, Lapinski, & Witte, 2011). Self-efficacy, on the other hand, refers to one's confidence in their ability to enact said recommended behavior. According to the EPPM, then, precautionary behavior like speaking with one's health care provider about breast density will be motivated only when an individual believes they have the ability to cope with a risk. This appraisal only occurs, though, if a perception of threat is induced by the risk message in the first place (Maloney, Lapinski, & Witte, 2011; Witte, 1992).

Refining the Conceptualization of EPPM Constructs

The EPPM and its application to risk perception research is not without its shortcomings. One main concern is in the validity and sophistication of the constructs central to the EPPM and their consistent application in extant research (Popova, 2012). Recent theorizing suggests risk perceptions, especially those related to the perception of risk likelihood (i.e.,

perceived susceptibility in the EPPM) and of risk severity, are more appropriately modeled as being comparative rather than absolute (Nahar, Vice, & Ford, 2013). Said another way, evidence suggests individuals make risk judgements not in a vacuum but instead based on some standard or in reference to other people or other risks.

Another concern in the application of the EPPM comes from risk perception and decision science research in which face validity concerns have arisen over the use of perceived susceptibility (Brewer, Weinstein, Cuite, & Herrington, 2004; Weinstein, 1999, 2000). Namely, it has been suggested and demonstrated, to an extent, that the original conceptualization of perceived susceptibility is often not applied in risk perception research and instead confounds multiple perceived threat constructs (Klein, Harris, Ferrer, & Zajac, 2011; Weinstein et al., 2007). Relatedly, there has been some suggestion that perceived threat in the EPPM ought to include more than just the two dimensions discussed thus far.

Comparative versus absolute risk perceptions. One overlooked distinction in risk perception research and the conceptualizing of risk perception constructs is the difference between *absolute* and *comparative* or *relative* risk perceptions (Nahar, Vice, & Ford, 2013). This distinction refers to whether an individual judges a risk on its own (e.g., absolute risk: "What are my chances of getting breast cancer?") versus judging personal risk in relation to another person (e.g., comparative risk: "*Compared to other women my age and race*, what are my chances of getting breast cancer?"), another disease (e.g., "My chances of getting breast cancer *are higher than my chances of getting other diseases I know about*"; "The consequences of me getting breast cancer *are more serious than* the consequences of me getting skin cancer"), or even a past version of oneself (e.g., "*Now that I know about my breast density*, my chances of getting breast cancer are higher").

A distinction between comparative and absolute threat judgments in the EPPM is warranted as evidence suggests individuals make automatic comparisons between themselves and others when judging their risk even when instructed to make absolute judgments (Klein & Weinstein, 1997). This type of distinction can also allow for more specific recommendations for message design to overcome related phenomena, like unrealistic optimism (Weinstein, 1982), wherein individuals inaccurately believed they are substantially less at risk than their peers. A brief scan of health communication and persuasion literature shows an inconsistent application of these types of items, seemingly with a preference toward absolute measures. This same trend has been found in health promotion research, as well (Nahar, Vice, & Ford, 2013).

The previously detailed treatment of risk perception conceptualization has only discussed likelihood judgements, but similar treatment applies to severity judgments. Accounting for comparative or relative risk judgement may also overcome often-observed ceiling effects in the judgement of risk severity (Weinstein, 1999), such that respondents view a studied threat as so serious there is no room for variation and covariation with other variables (e.g., Totzkay, 2018). It has been suggested that the appraisal of risk severity be conceived as being in comparison to other risks (e.g., "Compared to other diseases I know, the consequences of breast cancer are serious"), thereby accounting for individuals weighing how serious they believe other risks are and judging where the referent risk ranks in comparison (Janssen et al., 2011).

Given this theorizing and evidence, the EPPM can be adapted to include a comparative approach in the explication of its perceived threat constructs. Instead of a woman judging her likelihood of getting breast cancer after reading a breast density notification, it is more accurate that she judge her likelihood of getting breast cancer compared to other women like her. Likewise, instead of simply appraising the seriousness of breast cancer, a woman's post-breast density notification judgement is likely to be how serious breast cancer is relative to other

diseases she thinks about. Therefore, the conceptualizations of perceived susceptibility and perceived severity in this dissertation are comparative and relative, respectively, rather than absolute (i.e., believing one is more likely to experience a risk than similar others and that a risk is more severe than other risks, respectively) (see Table 1).

Table 1.

Distinction between risk perception constructs.

Construct	**Conceptual Definition**	**Operational Definition**	**Example Item**
Perceived Risk Likelihood	A deliberative, logical assessment of one's likelihood or probability of experiencing a risk which serves as a motivational drive to reduce one's risk.	The extent an individual perceives they are likely to experience breast cancer at some point in their life, compared with similar others.	"How likely do you think you are to get breast cancer at some point in your life, compared to other women your age and race who do not have dense breasts?"
Feelings of (Risk) Vulnerability	An intuitive, cognitive-emotional assessment of one's likelihood or probability of experiencing a risk which serves as a motivational drive to reduce one's risk.	The extent an individual *feels* they are likely to experience breast cancer at some point in their life, regardless of their logical likelihood assessment.	"Having dense breasts makes me feel that my chances of developing breast cancer at some point in my life are higher."
Risk-Related Worry	A negative affective state concerning the experience of a risk that serves as a motivational drive to reduce one's risk.	The extent an individual is preoccupied by negative affective states (e.g., worry, anxiety) concerning breast density.	"How worried are you about getting breast cancer at some point in your life?"
Perceived Risk Severity	A logical assessment of the seriousness of a risk's consequences, if an individual ere to experience said risk.	The extent an individual believes breast cancer's consequences are serious or severe, compared to the consequences of other risks.	"Compared to other diseases you know, how serious are the consequences of getting breast cancer?

Expanding the perceived threat construct. In addition to conceptual clarity within the EPPM, some theorizing suggests affective responses should be considered not just as a potential consequence of a threat appraisal that goes unobserved if sufficient efficacy information is thought to be embedded in a message, but actually as a regularly-measured risk response (Popova, 2012; Shen & Dillard, 2014). Recent research has identified that the ways perceived susceptibility has been conceptualized and operationalized already includes some elements of affect, in addition to otherwise being a somewhat muddled construct. What has generally been measured under the name of "perceived susceptibility" has actually been a mixture of perceptions of vulnerability, perceptions of risk likelihood, and, at times, risk-related worry (Klein, Harris, Ferrer, & Zajac, 2011; Klein, Zajac, & Monin, 2009; Portnoy, Kaufman, Klein, Doyle, & de Groot, 2014; Weinstein, Kwitel, McCaul, Magnan, Gerrard, & Gibbons, 2007).

One distinction to be made is between perceptions of likelihood and perceptions of susceptibility or vulnerability (Weinstein et al., 2007). It has often been the case in communication and health psychology research that the terms *susceptibility, likelihood,* and *probability* are used interchangeably when studying the EPPM's "perceived susceptibility" construct. However, this conflates separate constructs. Specifically, *perceived likelihood* most closely resembles the intended EPPM construct of how likely or probable individuals perceive a risk is to affect them. This deliberative process, though, is separate from more affective responses like *feeling vulnerable* and *concern or worry* (Weinstein et al., 2007).

Taking a "feelings of risk" approach, theorizing in decision science research conceptualizes perceived susceptibility as *feelings of vulnerability,* which is a cognitive-emotional state captured by sentiments such as "Having dense breasts *makes me feel that* my chances of getting breast cancer at some point in my life are higher" or "Not getting an annual mammogram *would make me feel like* I would be more likely to get breast cancer." In studies

where this version of perceived susceptibility has been distinctly measured, it has been only modestly associated with deliberative likelihood perceptions (e.g., Zajac, Klein, & McCaul, 2006). This suggests they are related but distinct constructs (Klein et al., 2011), but warrants continued empirical evaluation.

The separation of likelihood from susceptibility recognizes that individuals might logically understand a risk is not likely to affect them, but still *feel* like it could happen to them. This is a more intuitive, gut-level feeling experienced when anticipating a threat (Klein et al., 2011), much like the gist-based reasoning that guides risk response in frameworks like fuzzy trace theory (Reyna, 2005), and has been shown to consistently influence behavior (e.g., Loewenstein, Weber, Hsee, & Welch, 2001; MacGregor, 1991; McCaul & Mullens, 2003; Slovic, Finucane, Peters, & MacGregor, 2004). In fact, it has been found to be a better predictor of behavior in some situations than cognitive likelihood assessments (e.g., Janssen et al., 2011; Schmiege, Bryan, & Klein, 2009; Weinstein et al., 2007). For example, when assessing skin cancer risk, reports of participants' *feelings* of being at risk of skin cancer were consistent predictors of future sun protection, while cognitive/deliberative estimates of skin cancer likelihood were inconsistent or weaker predictors (Janssen et al., 2011).

Another distinct construct recognized in this dynamic risk perception mix is risk-related *worry.* This too is an affective-cognitive state, similar to feelings of vulnerability, that involves a motivational drive toward risk reduction behavior (Klein et al., 2011). Although, because of worry's conceptual overlap with feelings of vulnerability, the two are sometimes considered in tandem. However, some studies have measured worry distinct from feelings of vulnerability and deliberative likelihood estimates and consistently found evidence for discriminant validity and increases in predictive utility when treating these as three separate constructs (e.g., Ferrer et al., 2016). While the body of work explicitly distinguishing worry and feelings of vulnerability from

each other is limited, worry is conceptualized as feeling anxious or nervous about a risk (e.g., "*How worried are you* about getting breast cancer later in life?"), whereas feelings of vulnerability is conceptualized as a mix of gut-level intuitions regarding the likelihood of a risk affecting oneself (Janssen, van Osch, Lechner, & de Vries, 2015). Worry additionally has a similar action tendency to emotions like fear (Lazarus, 1991), which is to avoid or escape.

In general, worry is often ignored or measured only secondarily, likely contributing to its conflation with perceived likelihood and feelings of vulnerability. Indeed, uses of the EPPM frequently exclude measures of affect all together, despite it being a key part of the model (Popova, 2012). A meta-analysis of research analyzing the role of worry in risk communication, however, found worry was consistently induced separate from cognitive risk perceptions (Portnoy et al., 2014). This showed more factual and deliberative manipulations induced perceived likelihood independent of worry, while affective manipulations focusing on stories and vivid exemplars tapped more into worry. In another meta-analysis, being worried about breast cancer was found to be strongly associated with cancer screening (Hay, McCaul, & Magnan, 2006). Not only that, but worry was also independently induced by the perception of ambiguity around cancer screenings, apart from likelihood and feelings of vulnerability (Han, Moser, & Klein, 2006). This should be especially applicable in the case of breast density, as women have expressed concern over the ambiguity presented in breast density notification letters in both qualitative and quantitative studies (e.g., Gunn, Bataglia et al., 2018). Taken together, the affective state of worry is distinct from perceptions of likelihood and perhaps from feelings of vulnerability, and is a strong independent predictor of both behavioral intention and behavior that should be included in EPPM studies.

H5: *Perceived comparative likelihood, feelings of vulnerability, and risk-related worry are distinct constructs*.

EPPM and Risk Perception Summary

The EPPM predicts the intention to enact a risk-reducing behavior requires a sufficient perception of threat (i.e., risk severity and susceptibility), as well as a sufficient belief in one's ability to cope with said risk (i.e., response efficacy and self-efficacy). However, other research and theorizing suggests a more complex mix of threat perceptions. Wherein the EPPM's *perceived susceptibility* construct is more accurately conceived of as *perceived likelihood,* other related but distinct threat perceptions include affect-laden responses like *feelings of vulnerability* and *risk-related worry*. Additionally, perceived risk likelihood and perceived severity are more accurately conceived of in comparative or relative terms. When individuals make risk likelihood judgments, they tend to do so in comparison to others like them. Likewise, when individuals make risk severity judgements, they tend to weigh the seriousness of consequences against the consequences of other risks.

Incorporating all of this into the EPPM, then, means the threat appraisal is comprised of a comparative likelihood judgement, a relative severity judgement, an assessment of how at risk the individual feels, and the experience of worry related to the risk. Thus, in this dissertation's context, a woman should be motivated to speak with her health care provider about her breast density after reading a notification letter. This would be due to her believing density increases both her likelihood of getting breast cancer and the severity of the consequences of getting breast cancer, in addition to feeling like breast density makes her more at risk of getting breast cancer and to her being worried about her breast density. However, to motivate conversation with her health care provider, a woman must perceived threat while also believing she is able to communicate with her provider about her breast density and that doing so will help her avoid risk. This would require, of course, that breast density notifications are themselves effective in inducing the requisite constructs detailed in the EPPM.

RQ2: After *reading a breast density notification letter, to what extent do women report a) perceived relative severity, b) perceived comparative likelihood, c) feeling vulnerable to breast cancer, d) worry about breast density, e) response efficacy, f) self-efficacy, and g) behavioral intention?*

H6: *The intention to communicate with one's health care provider about breast density is positively predicted by a) perceived relative severity, b) perceived comparative likelihood, c) feeling vulnerable to breast cancer, d) worry about breast density, e) self-efficacy, and f) response efficacy.*

CHAPTER 4

Dissertation Summary

In all, this dissertation seeks to apply and test communication theory to the study of breast density notification letters. First, this dissertation will assess whether breast density notification letters have resulted in women knowing more about breast density and being more motivated to speak with their health care provider about their own breast density. As explained, the delivery of breast density notification letters after a woman receives a mammogram is currently mandated in 35 states with the intention to educate women and motivate them to bring that information to their health care provider for future health care decisions. These letters are sent with a woman's mammogram report, stating that while no cancer was found, she has dense breast tissue that can obscure mammograms and reduce radiologists' confidence in their conclusions. While these letters have been legally mandated in a majority of states, there continues to be little understanding of their impact on women's risk perceptions and behavior, nor of their impact on clinical encounters. In past studies that assess women's understanding and motivation, women are sampled only from states with legislation rather than those without mandates. Thus, no research examines if, at the state level, women tend to know more and be more motivated than women in other states. As such, this dissertation first samples women from states with and without breast density notification legislation and compares measures of understanding and motivation.

Second, to better delineate the motivational process these notification letters might be inducing, this dissertation applies the EPPM to study women's reactions to a hypothetical breast density notification letter. The EPPM is a well-tested theory of risk communication response, and this novel context allows for the incorporation of a number of theoretical advances to extend the utility of the EPPM. Specifically, the threat appraisal component of the EPPM, typically

including only an assessment of the severity of a risk and the likelihood of a risk affecting an individual, is explicated and then expanded to include two other constructs. Risk severity is specified to be comparative risk severity, due to findings supporting the notion that individuals do not judge risks in isolation, but instead how much more or less serious they are than other risks. Then, risk likelihood is specified to also be comparative, in that risk perception theories are concerned with perceived likelihood *now that a risk is known.* Then, following advances in risk perception theory indicating the importance of more gut-reaction feelings and risk-related worry, the EPPM's threat appraisal is expanded to include more intuitive assessments of risk vulnerability and the extent an individual is worried about a risk. In doing so, theory from communication science can be advanced while addressing a pressing public health concern. A summary of this dissertation's hypotheses and research questions is found in Table 2.

Table 2.

Study hypotheses and research questions.

Hypothesis		**Supported?**
1	Women likely to have received breast density notification letters have more accurate breast density knowledge than similar women who would not have received breast density notification letters.	*No*
2	Women who read a breast density notification letter have accurate breast density knowledge	*Yes*
3	Compared to similar women who would not have received breast density notification letters, women likely to have received breast density notification letters a) have greater intention to talk with their health care provider about their breast density, b) perceive greater self-efficacy for talking with their health care provider about their breast density, and c) perceive greater response efficacy for talking with their health care provider about breast density with regards to their decision making.	*No*
4	Women's intention to talk with the health care provider about their breast density is predicted by a) self-efficacy and b) response efficacy for talking with one's health care provider.	*Yes*
5	Perceived comparative likelihood, feelings of vulnerability, and risk-related worry are distinct constructs	*Yes*
6	The intention to communicate with one's health care provider about breast density is positively predicted by a) perceived relative severity, b) perceived comparative likelihood, c) feeling vulnerable to breast cancer, d) worry about breast density, e) self-efficacy, and f) response efficacy.	*Partially*
Research Question		
1	After reading a breast density notification letter, how will women's responses differ based on whether they are from a state with versus without breast density notification legislation?	*N/A*
2	Do women report positive a) perceived relative severity, b) perceived comparative likelihood, c) feeling vulnerable to breast cancer, d) worry about breast density, e) response efficacy, f) self-efficacy, and g) behavioral intention after reading a breast density notification letter?	*N/A*

CHAPTER 5

General Method Overview

To test the previously outlined hypotheses and answer the posed research questions, two studies were implemented. Data collections were conducted using the same sample parameters from Qualtrics, Inc. The first study was used to test hypotheses one, three, and four, investigating women's breast density understanding and motivation to talk with their health care provider about breast density in states with and without notification legislation. The second study collects data to apply the EPPM following exposure to a sample breast density notification letter to test hypotheses two, five, and six, as well as to answer research questions one, and two. For those data collections, women between 40 and 50 years of age with no personal history of cancer nor any experience with mammography were recruited to participate in either study. Study 1 includes a survey on motivational constructs and breast density knowledge. Study 2 includes exposure to an exemplar breast density notification message embedded within a lay mammogram report and then a survey relating to risk perceptions and intended behavior. For measurements, all items can be found in Tables 3 and 4. Unless otherwise noted, all scales were scored on 7-point, Likert-type scales ranging from the lowest or most negative value on the left to the highest or most positive value on the right (e.g., 1=strongly disagree, 7=strongly agree). For all scales, participants randomly viewed items with flipped anchors such that the most positive anchor is on the left and the most negative on the right (e.g., 1=strongly agree, 7=strongly disagree). This approach is used instead of using negatively-worded items due to observations that these tend to load on to separate factors in confirmatory factor analysis and are discarded in analyses (Irions, 2017). Lastly, shown in Table 6, sampling was unequal across states. This was primarily due to the specificity of the population and sample availability. However, given that comparisons are between states with and without legislation, rather than individual states, this was unproblematic.

Table 3.

Scale items and factor loadings for efficacy, intention, and breast density knowledge items (Studies 1 and 2)

Construct		Item Text	Scale Anchors	Factor Loading (Study 1)	Factor Loading (Study 2)
Breast Density Knowledge					
	1	Having dense breasts means I have breast cancer.	(1=strongly disagree, 7=strongly agree)	N/A	
	2	Breast density means that my mammogram is harder to interpret	1=strongly disagree, 7=strongly agree)	N/A	
	3	Dense breast tissue could cover up tumors on my mammogram.	(1=strongly disagree, 7=strongly agree)	N/A	
	4	There are options other than mammography that could be more accurate in screening for cancer.	(1=strongly disagree, 7=strongly agree)	N/A	
Behavioral Intention ($\propto_1$=.93, $\propto_2$=.90)					
	1	I intend to talk with my health care provider about my breast density.	(1=strongly disagree, 7=strongly agree)	.89	.82
	2	I am ____ to talk with my health care provider about my breast density.	(1=extremely unmotivated, 7=extremely motivated)	.97	.91
	3	I plan to talk with my health care provider about my breast density.	(1=strongly disagree, 7=strongly agree)	.86	.87
	4	My intention to talk with my health care provider about my breast density is…	(1=extremely low, 7=extremely high)	.77	.71

Table 3 (cont'd).

Construct		Item Text	Scale Anchors	Factor Loading (Study 1)	Factor Loading (Study 2)
Response Efficacy ($\propto_1$=.90, $\propto_2$=.93) *(adapted from Witte et al., 1996)*					
	1	Bringing information about my breast density to my health care provider will make my health care decisions more informed.	(1=strongly disagree, 7=strongly agree)	.82	.85
	2	If I bring information about my breast density to my health care provider, my ability to make more informed decisions about my health care will increase.	(1=strongly disagree, 7=strongly agree)	.90	.93
	3	Sharing my breast density information with my health care provider will make my ability to make health care decisions…	(1=much harder, 7=much easier)	.73	.81
	4	I will be able to better participate in my health care decisions if I bring my breast density information to my health care provider.	(1=strongly disagree, 7=strongly agree)	.87	.91
Self-Efficacy ($\propto_1$=.90, $\propto_2$=.93) *(adapted from Witte et al., 1996)*					
	1	I am confident in my ability to talk with my health care provider about breast density.	(1=strongly disagree, 7=strongly agree)	.74	.71
	2	Bringing my breast density information to my health care provider is…	(1=extremely difficult, 7=extremely easy)	.85	.89
	3	I am able to talk to my health care provider about my breast density.	(1=strongly disagree, 7=strongly agree)	.83	.94
	4	I feel confident that I can share the information about my breast density with my health care provider.	(1=strongly disagree, 7=strongly agree)	.94	.96

Table 4.

Scale items and factor loadings for risk perception items (Study 2).

Construct		Item Text	Scale Anchors	Factor Loading
Perceived Severity (∝=.80)		*(adapted from Janssen et al., 2011)*		
	1	Compared to other diseases you know, how serious are the consequences of getting breast cancer?	(1=not at all serious, 7=extremely serious)	.56
	2	The consequences of getting breast cancer are more serious than the consequences of other diseases I might get.	(1=strongly disagree, 7=strongly agree)	.80
	3	For me, breast cancer is more serious than other diseases I know about.	(1=strongly disagree, 7=strongly agree)	.76
	4	Compared to other diseases, the consequences of getting breast cancer are...	(1=much less bad, 7=much worse)	.72
Perceived Likelihood (∝=.92)		*(adapted from Ferrer et al., 2016)*		
	1	Compared to other women my age and race, having dense breasts makes me more likely to get breast cancer at some point in my life.	(1=strongly disagree, 7=strongly agree)	.88
	2	How likely do you think you are to get breast cancer at some point in your life, compared to other women your age and race who do not have dense breasts?	(1=not at all likely, 7=extremely likely)	.80
	3	Compared to other women your age and race, what do you think your chances are of getting breast cancer at some point in your life now that you know about your breast density?	(1=extremely low, 7=extremely high)	.87
	4	Having dense breasts makes my chances of getting breast cancer at some point in my life higher than other women my age and race who do not have dense breasts.	(1=strongly disagree, 7=strongly agree)	.87

Table 4 (cont'd).

Construct		Item Text	Scale Anchors	Factor Loading
Feelings of Vulnerability (∝=.94) *(adapted from Janssen et al., 2012, study 4)*				
	1	Having dense breasts makes me feel more likely to get breast cancer at some point in my life.	(1=strongly disagree, 7=strongly agree)	.90
	2	I feel vulnerable to getting breast cancer at some point in my life due to having dense breasts.	(1=strongly disagree, 7=strongly agree)	.85
	3	Having dense breasts makes me feel that my chances of getting breast cancer at some point in my life are higher.	(1=strongly disagree, 7=strongly agree)	.92
	4	Having dense breasts makes me feel ___ to getting breast cancer at some point in my life.	(1=not vulnerable at all, 7=extremely vulnerable)	.90
Breast Density Worry (∝=.96) *(adapted from Ferrer et al., 2016)*				
	1	How worried are you about your breast density?	(1=not at all worried, 7=extremely worry)	.94
	2	How anxious are you about your breast density?	(1=not at all anxious, 7=extremely anxious)	.91
	3	How nervous are you about your breast density?	(1=not at all nervous, 7=extremely nervous)	.93
	4	When you think of your breast density for a moment, how worried do you feel?	(1=not at all worried, 7=extremely worry)	.84
	5	When you think of your breast density for a moment, how nervous do you feel?	(1=not at all nervous, 7=extremely nervous)	.82
	6	When you think of your breast density for a moment, how anxious do you feel?	(1=not at all anxious, 7=extremely anxious)	.87

Table 4 (cont'd).

Construct		Item Text	Scale Anchors	Factor Loading
Outcome-Relevant Involvement (∝=.82) *(adapted from Cho & Boster, 2005)*				
	1	It is easy for me to think about the ways breast density affects my life.	(1=strongly disagree, 7=strongly agree)	.65
	2	All in all, the ways breast density impacts the reading of my mammogram is important to my life.	(1=strongly disagree, 7=strongly agree)	.49
	3	Breast density impacts my life.	(1=strongly disagree, 7=strongly agree)	.86
	4	My well-being is affected by breast density.	(1=strongly disagree, 7=strongly agree)	.75
	5	Breast density is an important issue to me.	(1=strongly disagree, 7=strongly agree)	.68

CHAPTER 6

Study 1

Method

Participants. Women aged 40-50 years (M=45.52, SD=3.14) with no personal cancer history and a mammogram in the past (N=322) from the states of West Virginia (n=35), Kentucky (n=95), South Carolina (n=54), Georgia (n=115), Vermont (n=5), and New Hampshire (n=18) were recruited from Qualtrics, Inc.'s paid panel service. This population of women was selected to overcome past studies' near-exclusive use of samples in regions with standing breast density notification laws and to test the present hypotheses and research questions. These states were chosen as half currently do not have laws in place (i.e., West Virginia, Georgia, New Hampshire), while the remainder do (i.e., Kentucky, South Carolina, Vermont). Geographically contiguous states with similar demographics were selected in pairs to match those with laws and those without (e.g., West Virginia paired with Kentucky). This age range was selected as this population of women is most likely to have dense breast tissue and thus is most likely to be receiving a breast density notification letter in affected states. A plurality of women identified as Caucasian/White (n=256), followed by African American/Black (n=54), Multiracial (n=6), Hispanic (n=3), and Asian/Pacific Islander (n=3). Additional demographic information can be found in Table 5.

Table 5.

Descriptive statistics for Studies 1 and 2.

	Study 1	Study 2
State Has Legislation		
Yes	154	115
No	168	147
Last Mammogram		
Less than 1 year ago	146	119
Between 1 and 2 years ago	88	69
Between 2 and 3 years ago	33	32
Between 3 and 4 years ago	15	8
Between 4 and 5 years ago	9	13
More than 5 years ago	31	21
Marital Status		
Single	56	39
Married	189	139
Civil Union	6	8
Divorced	58	52
Widowed	9	10
Prefer not to say	4	4
Education		
Some high school	11	6
High school diploma/GED	72	63
Vocational/technical degree or certification	28	27
Some university/college	81	66
Community college	27	27
4-year university	58	50
Master's degree	36	20
Doctoral/professional degree	9	3
Income Level		
Less than $30,000	97	79
$30,000 - $39,999	48	32
$40,000 - $49,999	27	28
$50,000 - $59,999	29	32
$60,000 - $69,999	14	25
$70,000 - $79,999	24	16
$80,000 - $89,999	15	11
$90,000 - $99,999	13	12
$100,000 or more	55	27

Procedure. After providing informed consent, participants first confirmed they were women, between the ages of 40 and 50 years, had no cancer history, and had received a mammogram in the past. They then reported whether they had heard of breast density before and whether they had been told they had dense breasts by a health care provider, a family member, a friend, or some other source. Then, participants reported their breast density knowledge and their motivation to talk with their health care provider about their breast density. Finally, other demographic information was collected (e.g., race/ethnicity, income level, family cancer history).

Measures. The following description of measures will present only example items from each construct under study. All breast density knowledge, efficacy, and intention items can be found in Table 3. Unless otherwise noted, all scales were scored on 7-point, Likert-type scales (e.g., 1=strongly disagree, 7=strongly agree).

Breast density knowledge. Following breast density notification goals and past misunderstandings found in qualitative work (e.g., Totzkay, Thomas et al., 2018), women rated the extent they agreed that dense breast tissue complicated mammogram interpretation and there are other options that mammography to screen for cancer (i.e., notification goals), as well as dense tissue means one has cancer and dense tissue can be physically felt (i.e., misperceptions).

Self-efficacy. Participant self-efficacy for talking with one's doctor (α=.90) (adapted from Witte, Cameron, McKeon, & Berkowitz, 1996) was measured with four items asking about a participant's confidence and ability to talk with their health care provider about breast density (e.g., "I am confident in my ability to talk with my health care provider about breast density.").

Response efficacy. Response efficacy (α=.90) (adapted from Witte et al., 1996) was measured by asking participants about whether they believe knowing their breast density will improve their participation in shared decision making with four items (e.g., "Bringing

information about my breast density to my health care provider will make my health care decisions more informed.").

Intention to talk with health care provider. Behavioral intention for talking with one's health care provider (α=.93) was assessed with four items, asking participants how much they intend to and how motivated they are to talk with their health care provider about breast density.

Results

Confirmatory factor analysis was conducted in R, while SPSS was used for other inferential and descriptive statistics. In the following, factor analysis results are presented first. Then, other hypotheses are reviewed with their respective inferential tests. In-text reported coefficients are reported as standardized, when available. Table 6 shows means, standard deviations, 95% confidence intervals, and inter-variable correlations for Study 1 variables.

Table 6.

Means (with standard deviations), correlations, and scale reliability coefficients for Study 1 constructs measured with 7-point scales.

	M (SD) [95% CI]	1.	2.	3.	4.	5.	6.	7.
1. Intention to Talk	5.23 (1.44) [5.08, 5.39]	*(.93)*						
2. Talk Response Efficacy	5.75 (1.09) [5.63, 5.86]	**.58***	*(.90)*					
3. Talk Self-Efficacy	5.87 (1.17) [5.74, 5.99]	**.37***	**.27***	*(.90)*				
4. Density Knowledge, Have Cancer	2.35 (1.38) [2.30, 3.50]	.02	-.04	**-.20***	-			
5. Density Knowledge, Interpret	5.07 (1.24) [4.93, 5.20]	-.05	.10	-.01	**-.17***	-		
6. Density Knowledge, Can Feel	3.91 (1.46) [3.75, 4.07]	.11	.07	-.05	.05	-.04	-	
7. Density Knowledge, Other Options	4.41 (1.63) [4.22, 4.59]	.06	.07	.10	-.10	.09	**.13***	-

*=p<.05

Confirmatory factor analysis. Confirmatory factor analysis assessed internal consistency and parallelism (Hunter, 1982) using the lavaan R package. Fit is assessed using a number of indices. A standardized root-mean square residual (SRMR), measuring the discrepancy between the theoretical measurement model and the sample, of less than or equal to .08 demonstrates acceptable model fit (Hu & Bentler, 1999). Incremental fit indices, like the comparative fit index (CFI), indicate the relative improvement in a model's fit with the data compared to the null model in which there is no covariance among observed variables (Kline, 2016). The closer this value is to 1.0, the better the fit with the data; it is generally accepted when above .90, but preferably above .95. Another fit index to use in evaluating a model's fit with the data is the root mean square error of approximation (RMSEA), which is a "badness-of-fit" index that is parsimony-adjusted, such that model complexity penalizes the measure. The closer the RMSEA is to 0.0, the better, and should be at least below .10, but preferably below .05 (see Kline, 2016). Finally, the model χ^2 tests the null hypothesis of exact or perfect fit such that a nonsignificant test indicates good fit.

The measurement model with three factors (i.e., intention, self-efficacy, and response efficacy) fit the data well, $\chi^2(51)=74.89$, $p<.05$, CFI=.99, RMSEA=.04 90% CI [.02, .06], SRMR=.03. No residual patterns were observed that would justify model re-specification and cross-loadings were not problematic. Table 3 shows factor loadings of each item on the respective latent construct.

Hypothesis testing. Hypothesis one states that women in states with a breast density notification letter mandate have more accurate breast density knowledge than similar women in states without a breast density notification letter mandate. To test this hypothesis, independent sample t-tests were conducted for each breast density knowledge item between states with and

without notification legislation. As shown in Table 7, the only variable women differed in their agreement on was that breast density complicating mammogram interpretation. Albeit counter to expectation, it was found that women in states without legislation agreed with this statement to a greater extent (M=5.20, SD=1.15) than women in states with legislation (M=4.92, SD=1.31), t(320)=2.00, $p<.05$, $d=.23$. Analysis of covariance was also conducted for each knowledge item, controlling for other knowledge indices, as well as for each psychometric construct, controlling for other constructs. Both sets found results consistent with simple t-test analyses. Therefore, hypothesis one was not supported. However, it should be noted, as seen in pooled means with 95% confidence intervals in Table 6, that sampled women on average, regardless of legislation, accurately reported dense tissue did not mean cancer was necessarily present (M=2.35, SD=1.38, 95% CI [2.30, 3.50]), dense tissue complicated mammogram interpretation (M=5.07, SD=1.24, 95% CI [4.93, 5.20]), and that there are options other than mammography to screen for cancer (M=4.41, SD=1.63, 95% CI [4.22, 4.59]). Participants did not, however, differ from the scale midpoint of 4="neither agree nor disagree" for whether dense tissue can be physically felt (M=3.91, SD=1.46, 95% CI [3.75, 4.07]).

Hypothesis three states that, compared to similar women in states without a breast density notification letter mandate, women in states with a breast density notification mandate a) report greater intention to talk with their health care provider about their breast density, b) perceive greater self-efficacy for talking with their health care provider about their breast density, and c) perceive greater response efficacy for talking with their health care provider about breast density. This hypothesis was tested with independent sample t-tests for each construct for women in states with versus without breast density notification legislation. As showing in Table 7, there were no differences between states. Therefore, hypothesis three was not supported. However, as shown in the same table and in Table 6 with pooled means and 95% confidence intervals, women

on average reported positive values of self-efficacy, response efficacy, and intention to talk with their health care provider about breast density regardless of legislation.

Table 7.

Mean differences between states with and without breast density notification legislation (Study 1)

	State Has Legislation			
	Yes	**No**	**t (320)**	**d**
Intention to Talk	5.21 (1.45) [4.98, 5.45]	5.26 (1.42) [5.04, 5.46]	.30	.03
Talk Response Efficacy	5.72 (1.12) [5.54, 5.90]	5.77 (1.07) [5.62, 5.93]	.003	.05
Talk Self-Efficacy	5.87 (1.23) [5.66, 6.06]	5.87 (1.12) [5.71, 6.04]	.42	0.0
Knowledge, Cancer	2.40 (1.32) [2.18, 2.64]	2.30 (1.34) [2.11, 2.52]	-.64	.08
Knowledge, Interpret	4.92 (1.31) [4.71, 5.12]	5.20 (1.15) [5.02, 5.36]	**2.00***	**.23**
Knowledge, Can Feel	3.87 (1.42) [3.64, 4.10]	3.95 (1.51) [3.71, 4.18]	.47	.05
Knowledge, Other Options	4.38 (1.63) [4.10, 4.63]	4.43 (1.62) [4.16, 4.67]	.28	.03

*=p<.05

Finally, hypothesis four states women's intention to talk with their health care provider about their breast density is predicted by a) self-efficacy and b) response efficacy for talking with one's health care provider. This was tested by regressing intention on both self-efficacy and response efficacy. Shown in Table 8, supporting hypothesis four, both constructs positively predicted intention to talk with one's health care provider, Adj. R^2=.38. It should be noted that the pattern of results did not differ with the inclusion of indicators for the breast density knowledge indices and a dummy variable for whether a woman's state had breast density notification legislation, which were all nonsignificant predictors.

Table 8.

Predicting the intention to talk with one's health care provider about breast density (Study 1).

	B (SE)	**ß**
Talk Self-Efficacy	**.29*** (.06)	**.23**
Talk Response Efficacy	**.67*** (.06)	**.51**
Constant	-.31 (.41)	-
F (df)	**97.85*** (2, 319)	
R2	.38	
Adj. R2	.38	

*=p<.05; *Note:* Results are unchanged with the inclusion of breast density knowledge and whether participant was from a state with legislation.

Discussion

The purpose of the first portion of this dissertation was to assess women's familiarity with breast density and their motivation to talk with their health care provider across states with and without breast density notification legislation enacted. This legislation and the subsequent notification letter sent to women post-mammogram are meant to increase women's awareness of mammography's limitations and motivate conversation about that and dense breast tissue in general with their health care provider (Molleran, 2014; O'Neill et al., 2014). To assess if this was indeed the case, data were collected from women in three states with notification legislation (i.e., South Carolina, West Virginia, and Vermont) and three comparable states that did not have legislation (i.e., Georgia, Kentucky, and New Hampshire).

In this sample, women in states with legislation mandating breast density notification mostly did not differ in knowledge and motivation from women in states without such legislation. There was a difference, however, in women's response to the item asking if dense breast tissue complicated mammogram interpretation. For this item, it was actually the case that

women in states without legislation more strongly agreed, accurately so, that dense tissue complicated mammogram interpretation. Both groups of women were accurate, but given the nature of the measurement used here, women who were not likely to have already received a breast density notification letter in the past more strongly agreed with the provided statement.

It was also the case that the sample, regardless of whether one's state had legislation or not, was ambivalent about whether dense breast tissue could be physically felt. As detailed in the literature review, dense breast tissue is a *screening* outcome and not a clinical nor physical one (Smith, 2013); dense tissue can only be discovered and categorized as such *after* a mammogram has been conducted and images are reviewed by a radiologist. This ambivalence is similar to that observed in past qualitative research (e.g., Gunn, Bataglia et al., 2018; Totzkay, Thomas et al., 2018), and may again reflect women conflating dense breast tissue with a phenomenon known as *fibrocystic breasts*. Fibrocystic breasts come about from breast tissue changes that create cysts or areas of fibrous tissue in the breast (American Cancer Society, 2018b). Especially given the role of fibrous tissue, similar imaging concerns as dense tissue arise from this condition. However, these are distinct phenomena (DenseBreast-Info, Inc., 2018a). Namely, fibrocystic breasts can be physically observed in a breast exam, while breast density can only be observed via mammogram (see Freer, 2015; Smith, 2013). This misunderstanding may result in a provider communicating "density" information to a woman that actually refers to fibrocystic breasts, especially given the documented lack of understanding by health care providers (e.g., Gunn, Kressin et al., 2018).

Study 1 also found no differences between women in states with and without breast density notification in their reported intention to talk with their health care provider about breast density, their perceived self-efficacy to do so, and their perceptions of this communication's response efficacy. While these were all positive between the two groups of women, indicating

these women were indeed motivated to talk with their health care providers about breast density and felt efficacious about doing so, it suggests breast density notifications may not be succeeding in their intended goals. This, however, cannot fully be ascertained with these data. It might be the case that women in states without legislation have some other source for breast density information that has increased their motivation and efficacy perceptions to the same extent as breast density notification letters do for women in the respective states. It might also be the case that women, in general, feel capable of communicating about their breast health with their health care providers, so prompted recall from close-ended questionnaires result in positive self-reports. Along these lines, women might be espousing the "more is better" approach to health information in shared decision making, which is not only the same approach used for breast density notification letters (e.g., Jones & Stevens, 2014), but typical to the patient-centered care movement more generally (Epstein & Street, 2011). Whatever the case, it is clear that more data are necessary to better assess whether this is the case in the broader population of states with and without legislation and, perhaps, with more refined and nuanced measurements of knowledge and sources of breast density information.

Lastly, as expected, it was observed that intention was predicted by perceptions of efficacy. Though these data are cross-sectional, meaning causal inference cannot be attributed, this association suggests that women's plans to talk with their health care providers about breast density may be influenced by their efficacy perceptions, regardless of whether they have received a breast density notification or not. Though the notifications may not necessarily be influencing women's efficacy perceptions, tailoring messages about breast density for women is likely a useful strategy if one's goal is to motivate conversations about breast density.

Overall, the data from Study 1 suggest breast density notification letters may not be necessarily succeeding in their educational and motivational goals. At the very least, they do not

appear to be adding informative and motivational value above and beyond other educational initiatives or information dissemination activities that may be taking place with the broader population. At any rate, there may be other motivational processes in play following the reception of a breast density notification letter. This is now explored in a second study that shows women a typical breast density notification letter and then measures their risk perceptions and motivation following exposure to assess what motivational processes might be at play.

CHAPTER 7

Study 2

Method

Participants. As in Study 1, women aged 40-50 years (M=45.59, SD=3.10) with no personal cancer history (N=362) from West Virginia (n=26), Kentucky (n=66), South Carolina (n=43), Georgia (n=107), Vermont (n=4), and New Hampshire (n=16) were recruited from Qualtrics, Inc.'s panel service. A plurality of women identified as Caucasian/White (n=213), followed by African American/Black (n=36), Multiracial (n=6), Hispanic (n=4), and Asian/Pacific Islander (n=3). A breakdown of additional demographic information can be found in Table 6.

Procedure. After providing informed consent, as in Study 1, participants first confirmed they were women, between the ages of 40 and 50 years, had no cancer history, and received a mammogram in the past. Then, participants viewed a sample breast density notification message that was preceded by text serving as an involvement induction to ensure attention (see below). Once participants read the message, they answered an involvement induction check and reported their breast density knowledge. They then answered breast cancer risk perception and behavioral intention items, all randomly ordered across constructs as well as randomly ordered across individual indicators within respective constructs. Finally, other demographic information was collected.

Materials. All participants first viewed an involvement induction and then a sample breast density notification letter.

Involvement induction. Following past persuasion research on involvement and message processing (Petty & Cacioppo, 1986), participants read a brief message prior to the actual breast density notification message to induce involvement: "You are a part of a select group of women

helping to understand the impact of information related to women's health. The results from this study will be used to improve the communication between women and their health care providers and practices related to the delivery of health information, in general. Your opinion will be weighed heavily in decision-making around this, so your full attention would be greatly appreciated."

Breast density message. All participants viewed a sample breast density notification letter from New York, as it is most similar to other letters and has the best readability and accessibility ratings of the mandated letter text (Kressin et al., 2016; Yeh et al., 2015). This text is embedded within the Mammogram Report Lay Letter (adapted from American College of Radiology, 2018b), which is recommended to be used when sending women their mammogram results (see Appendix).

Measures. The following description of measures will present only example items from each construct. Again, all items can be found in Tables 3 and 4. Unless otherwise noted, all scales were scored on 7-point, Likert-type scales (e.g., 1=strongly disagree, 7=strongly agree).

Outcome-relevant involvement. Outcome-relevant involvement (α=.82) (adapted from Cho & Boster, 2005) was measured with five items. This induction check asked participants the extent breast density affected their or how important they felt it was to them (e.g., "It is easy for me to think about the ways breast density affects my life.").

Perceived severity. Perceived severity (α=.80) (adapted from Janssen et al., 2011) was measured with four relative severity items. These items asked participants to rate the seriousness of breast cancer's consequences, compared to other diseases they know of (e.g., "Compared to other diseases you know, how serious are the consequences of getting breast cancer?).

Perceived risk likelihood. Perceived breast cancer likelihood (α=.92) (adapted from Ferrer et al., 2016) was measured using four comparative likelihood items. These scales asked

participants to rate their likelihood of developing breast cancer, now that they know about breast density, compared to other women their age and race (e.g., "Compared to other women my age and race, having dense breasts makes me more likely to get breast cancer at some point in my life").

Feelings of vulnerability. Feelings of vulnerability regarding breast cancer (α=.94) (adapted from Janssen et al., 2012, Study 4) was measured using four items. These items asked participants, now that that know about breast density, what they *feel* their likelihood of developing breast cancer is (e.g., "Having dense breasts makes me feel more likely to get breast cancer at some point in my life") and their perceptions of vulnerability for developing breast cancer (e.g., "I feel vulnerable to getting breast cancer at some point in my life due to having dense breasts").

Worry. Participant worry was measured as both *worry about breast density* (α=.96). To assess worry for either referent, participants reported whether it makes them feel worried, anxious, or nervous to five items (adapted from Ferrer et al., 2016).

Self-efficacy, Response Efficacy, Intention, and Breast Density Knowledge. Participant self-efficacy regarding talking with one's doctor (α=.93), response efficacy (α=.93), behavioral intentions for talking with one's health care provider (α=.90), and breast density knowledge were all measured with the same items as in Study 1.

Results

Confirmatory factor analysis and structural equation modeling were conducted in R, while SPSS was used for descriptive analyses, linear regression, and mediation analysis. In the following, factor analysis results are presented first with the relevant hypothesis test. Then, other hypotheses are reviewed with their respective tests using linear regression, mediation analysis, and structural equation modeling. In-text reported coefficients are standardized, including

indirect effect size estimates. Table 9 shows means, standard deviations, 95% confidence intervals, and inter-variable correlations for Study 2 variable**s.**

Confirmatory factor analysis. As in Study 1, confirmatory factor analysis assessed internal consistency and parallelism (Hunter, 1982) using the lavaan R package. This was used to test both the general measurement model to be used in analyses as well as hypothesis five, which states perceived comparative likelihood, feelings of vulnerability, and risk-related worry are distinct constructs.

The measurement model with eight factors (i.e., intention, response efficacy, self-efficacy, worry, severity, vulnerability, and likelihood), predicted in hypothesis five, fit the data well, $\chi^2(532)=979.251$, $p<.05$, CFI=.94, RMSEA=.06 90% CI [.05, .06], SRMR=.06. The data fit this model better than both the four factor model that combined all perceived threat variables into a single index, $\chi^2(554)=2636.09$, $p<.05$, CFI=.73, RMSEA=.12 90% CI [.11, .12], SRMR =.10, and the five-factor model that included worry separate from the other combined threat variables, $\chi^2(550)=1904.23$, $p<.05$, CFI=.82, RMSEA=.10 90% CI [.09, .10], SRMR=.10. Therefore, hypothesis four was supported and no residual patterns emerged that would justify model re-specification and cross-loadings were not problematic. Tables 3 and 4 shows factor loadings of each item on the respective latent construct.

Table 9.

Means (with standard deviations), correlations, and scale reliability coefficients for Study 2 constructs measured with 7-point scales.

	M (SD) 95% CI	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
1. Intention to Talk	5.90 (1.12) [5.76, 6.05]	*(.90)*											
2. Talk Response Efficacy	5.92 (1.01) [5.79, 6.04]	**.49***	*(.93)*										
3. Talk Self-Efficacy	5.98 (1.07) [5.84, 6.11]	**.33***	**.46***	*(.93)*									
4. Breast Density Worry	4.18 (1.44) [4.01, 4.35]	**.35***	.08	-.05	*(.96)*								
5. Perceived Severity	5.05 (1.13) [4.90, 5.19]	**.18***	**.25***	.07	**.37***	*(.80)*							
6. Perceived Vulnerability	4.32 (1.44) [4.15, 4.49]	**.26***	**.13***	-.04	**.68***	**.40***	*(.94)*						
7. Perceived Likelihood	4.05 (1.33) [2.90, 4.22]	**.18***	.12	**-.12***	**.56***	**.30***	**.73***	*(.92)*					
8. Involvement	4.57 (1.16) [4.44, 4.72]	**.30***	**.17***	-.02	**.40***	**.26***	**.35***	**.26***	*(.83)*				
9. Knowledge, Cancer	1.97 (1.26) [1.81, 2.12]	-.08	**-.16***	**-.27***	**.22***	.10	**.30***	**.33***	**.15***	-			
10. Knowledge, Interpret	5.65 (1.32) [5.48, 5.81]	**.18***	**.18***	.12	.01	-.03	-.02	-.04	-.01	**-.24***	-		
11. Knowledge, Can Feel	3.76 (1.52) [3.57, 3.94]	-.06	-.09	-.08	-.02	.07	.04	.09	**.15***	**.22***	-.05	-	
12. Knowledge, Other Options	5.01 (1.57) [4.82, 5.21]	.07	**.17***	**.17***	-.02	-.06	.03	-.03	.001	-.09	**.31***	**.19***	-

*=$p<.05$

Hypothesis testing. Hypothesis two states that women who read a breast density notification letter have accurate breast density knowledge. Research question two asked if women, after reading a breast density notification letter, report positive a) perceived relative severity, b) perceived comparative likelihood, c) feeling vulnerable to breast cancer, d) worry about breast density, e) response efficacy, f) self-efficacy, and g) behavioral intention. These were answered using one-sample t-tests against the scale midpoint (i.e., 4=neither agree nor disagree) to generate 95% confidence intervals around each construct's mean value. As shown in Table 9, perceived comparative likelihood was the only construct to not differ significantly from the scale midpoint (M=4.05, SD=1.33, 95% CI=[2.90, 4.22]), t(261)=.651, p=.52. All other constructs were reported above the scale midpoint after viewing the breast density notification. Because breast density knowledge indices all differed significantly from the scale midpoint and in the expected direction, hypothesis two was supported.

Research question one asked how women's post-notification responses would differ based on whether they are from a state with versus without a breast density notification mandate. This was tested with independent sample t-tests for each construct for women in states with versus without density notification legislation. As shown in Table 10, the only difference was for self-efficacy, such that women in states without legislation reported higher self-efficacy after reading the breast density notification (M=6.10, SD=.93), compared to women in states with legislation (M=5.82, SD=1.21), t(260)=2.51, p<.05, d=.26.

Table 10.

Mean differences between states with and without breast density notification legislation (Study 2)

	State Has Legislation			
	Yes	**No**	**t (260)**	**d**
Intention to Talk	5.75 (1.21) [5.53, 5.97]	6.02 (1.02) [5.86, 6.17]	1.96	.24
Talk Response Efficacy	5.80 (1.11) [5.60, 5.99]	6.01 (.92) [5.86, 6.16]	1.71	.21
Talk Self-Efficacy	5.82 (1.21) [5.60, 6.03]	6.10 (.93) [5.96, 6.25]	**2.51***	**.26**
Breast Density Worry	4.13 (1.41) [3.87, 4.40]	4.22 (1.46) [3.97, 4.45]	.46	.09
Perceived Severity	4.95 (1.10) [4.73, 5.15]	5.13 (1.16) [4.94, 5.31]	1.25	.16
Perceived Vulnerability	4.30 (1.50) [4.01, 4.58]	4.34 (1.41) [4.12, 4.58]	.18	.03
Perceived Likelihood	3.96 (1.38) [3.71, 4.22]	4.12 (1.29) [3.93, 4.31]	.97	.12
Involvement	4.55 (1.12) [4.36, 4.76]	4.59 (1.19) [4.40, 4.79]	.28	.03
Knowledge, Cancer	1.92 (1.29) [1.70, 2.15]	2.00 (1.24) [1.81, 2.21]	.50	.06
Knowledge, Interpret	5.74 (1.31) [5.50, 5.97]	5.57 (1.33) [5.34, 5.78]	-1.02	.13
Knowledge, Can Feel	3.78 (1.54) [3.51, 4.07]	3.73 (1.50) [3.48, 3.96]	-.25	.03
Knowledge, Other Options	4.99 (1.44) [4.72, 5.24]	5.03 (1.68) [4.75, 5.29]	.18	.03

*=$p<.05$

Finally, hypothesis six states the intention to communicate with one's health care provider about breast density is positively predicted by a) perceived relative severity, b) perceived comparative likelihood, c) feeling vulnerable to breast cancer, d) worry about breast density, e) perceived self-efficacy, and f) perceived response efficacy. As shown in Table 11, this hypothesis was not entirely supported: intention was only significantly predicted by self-efficacy, β=.17, response efficacy, β=.38, and worry about breast density, β=.31, Adj. R^2=.36. The added control variable of outcome-relevant involvement was also a significant predictor of intention,

β=.15, but the pattern of results was otherwise unaffected by its inclusion. Perceptions of comparative severity, comparative likelihood, and vulnerability did not significantly predict intention to talk with one's health care provider about breast density.

Table 11.

Predicting the intention to speak with one's health care provider about breast density (Study 2).

	B (SE)	**Beta**	**Indirect Effect via Worry**
Talk Self-Efficacy	**.18*** (.06)	**.17**	-
Talk Response Efficacy	**.42*** (.07)	**.38**	-
Breast Density Worry	**.24*** (.06)	**.31**	-
Perceived Risk Severity	-.07 (.06)	-.07	**.04*** (.02) [.01, .08]
Perceived Vulnerability	.004 (.07)	.01	**.12*** (.03) [.07, .19]
Perceived Likelihood	-.03 (.06)	-.03	.03 (.02) [-.002, .09]
Involvement	**.14*** (.05)	**.15**	**.06*** (.02) [.02, .12]
Constant	**1.20*** (.46)	-	-
F (df)	**21.65*** (7, 254)		
R2	.37		
Adj. R2	.36		

*=p<.05

Post-hoc analysis. Contrary to predictions, worry was the only risk perception to predict intention, despite significant correlations between the other risk perceptions and intention (see Table 9). It might be that in the original theoretical model of the EPPM that an affective response, though not necessarily *fear*, per se, could indeed be a consequence of threat appraisal rather than a part of it. This would be contrary to more contemporary views that suggest affective responses be considered part of the EPPM's threat appraisal and not just a consequence of it (Popova, 2012; Shen & Dillard, 2014). To test if this was the case, post-hoc mediation tests using the PROCESS macro for SPSS (Hayes, 2013) generated point-estimates and 95% bias-corrected

bootstrap confidence intervals (based on 10,000 resamples) for each indirect effect. Indirect estimates are interpreted as standard deviation changes of the dependent variable given a standard deviation increase in an independent variable. Shown in Table 11, nonzero indirect effect point estimates through breast density worry, indicating a significant indirect effect on intention, were found for perceived severity, b=.04 95% CI [.01, .08], and perceived vulnerability, b=.12 95% CI [.07, .19]. The indirect effect point estimate range for perceived comparative likelihood included zero, indicated a nonsignificant indirect effect on intention through worry. These data, then, support a mediating relationship for worry in the EPPM, rather than it being included in tandem with the threat appraisal variables

Discussion

The purpose of Study 2 was to assess whether women reported accurate knowledge about breast density after reviewing a typical breast density notification, as well as whether or not doing so resulted in a motivation process likely to result in women talking with their health care provider about breast density. In doing so, several theoretical questions regarding the EPPM were addressed in order to not only begin to parse out what process may or may not be induced by these notifications, but also to refine communication science frameworks and generate new theoretical questions. Women from six states, three with breast density notification legislation and three without, provided self-report data after reading a breast density notification that begins to generate needed evidence in breast density and risk perception research.

Overall, these data showed all relevant risk perception constructs, other than perceived risk likelihood, were reported in the positive direction. This means, after reading the breast density notification letter, women reported that breast cancer had more serious consequences than other diseases they knew, dense breasts would make them feel more at risk of developing breast cancer, and breast density made them worried. This was in addition to reporting being

comfortable or efficacious with talking with their health care provider about breast density and believing that doing so would help them better take part in their health care decision making. It was also the case that these women accurately reported that dense breast tissue complicated mammography interpretation and that there were options other than mammography to screen for cancer, resembling the goals of this legislation. They further reported it did not mean they have cancer and was not something that could physically be felt, which are two prominent misperceptions observed previously. These data, though, showed that participants were ambivalent about their perceived risk likelihood; when reporting whether having dense breast tissue made them more or less at risk for developing breast cancer than other women of similar age and race, the women in this sample, on average, reported ambivalent beliefs. This is despite the notification text stating that dense tissue increases cancer risk.

A key part of this dissertation in Study 2 was the prediction of women's intention to speak with their health care provider. The strongest statistical predictors of intention after reading the notification were worry about breast density and perceived response efficacy. This translates to women being negatively preoccupied with breast density and believing that speaking with their health care provider about it would increase their ability to participate in health care decision making lead to women planning to talk with their health care provider about their breast density. While perceptions of severity and feeling vulnerable because of breast density did not appear to directly impact intention, these data suggest they increase women's worry about breast density which then increases intention. So, it would appear concerns about the potential for breast density notifications increasing worry or anxiety in women (e.g., Haas & Kaplan, 2015; Klinger et al., 2016; Rey, Price, & Joe, 2015) may be founded. Yet, worry or anxiety in this case may actually promote precautionary behavior. Implications for this observation for practice and for EPPM theorizing will be elaborated on later in this dissertation.

In sum, Study 2 found some support for the motivational potential of breast density notification letters and some support for their ability to educate. However, these findings are tentative given methodological limitations such as a lack of a control condition in the present study and in an unequal distribution of participants from an already small subset of states. However, these data provide a starting point for research that explores the consequences of breast density notification letters. They also give additional insight into what occurs to women after they receive notifications, and information to evaluate the EPPM in a way that can extend communication science. These implications are explored next in tandem with Study 1's results and in the greater context of this dissertation.

CHAPTER 8

General Discussion

This dissertation sought to use an established communication science paradigm to begin to understand the consequences of receiving a breast density notification letter, a mandate in the majority of U.S. states for women who have dense breast tissue observed in mammograms. An emerging public health focus, dense breast tissue appears white on mammograms due to its composition of overlapping epithelial tissue that reflects x-rays (Wang et al., 2014). Approximately half of the screening population (i.e., women over the age of 40) has dense breast tissue and women between the ages of 40 and 50 years are especially likely to have dense tissue (Sprague et al., 2014).

As breast density is an emerging research area, there is limited social scientific research to date that investigates the impact of notification letters on women's understanding, perceptions, and subsequent decision making. Much of the existing research uses interviews or focus groups, though survey research has been conducted using primarily single regional samples. From these studies, it appears women either do not know very much about breast density (Gunn, Bataglia et al., 2018) or exhibit misinformation and confusion over information sources (Totzkay, Thomas et al., 2018). Outside of that, some research has explored outcomes of receiving a notification of breast density post-mammogram, including an increased intention to speak with one's health care provider about their breast density (Manning et al., 2017). However, due to sampling limitations and a lack of theoretical application, generalization of findings from this research is limited. This dissertation sought to collect more generalizable findings regarding women's understanding of breast density and to explore motivational mechanisms to women's intention to speak about breast density with their health care providers as a consequence of receiving a breast

density notification letter. This was done by sampling women from states with notification legislation and women from states without legislation.

The main motivational process explored in this dissertation is outlined by the EPPM (Maloney, Lapinski, & Witte, 2011). This framework is well-accepted in health communication and health promotion research, but has largely not been extended with innovations in risk perception theorizing nor has some conceptual confusion been addressed. For example, some validity concerns have arisen regarding the central risk perception constructs in the EPPM, as well as the specificity at which the constructs are operationalized (e.g., Nahar, Vice, & Ford, 2013; Popova, 2012). Following research and theorizing in risk perception and decision science, this dissertation applies risk perception as comparative rather than absolute, wherein individuals assess how at risk they are and how serious a risk is compared to other people like them and other diseases they know, respectively (Brewer, Weinstein, Cuite, & Herrington, 2004; Janssen et al., 2011; Weinstein, 1999, 2000). This reflects evidence suggesting individuals automatically make these types of comparative assessments rather than the previously-used "absolute" risk perception judgements. Additionally, this dissertation addresses theorizing that suggests the perceived threat construct of the EPPM may not simply be made of two dimensions. Instead, it has been suggested that risk-related worry ought to be included as a relevant risk response, and that perceived susceptibility has both deliberative (i.e., perceived likelihood) and more affective (i.e., feelings of vulnerability) components (Han et al., 2006; Klein et al., & Zajac, 2011; Portnoy, et al., 2014; Weinstein et al., 2007).

This dissertation addresses issues surrounding breast density and theoretical refinements in the EPPM with two studies. First, women's perceptions and knowledge of breast density and relevant motivational constructs regarding their talking to health care providers about their own breast density were measured. This included women from states with and without breast density

notification legislation who have had a mammogram, given past findings suggesting women have trouble accurately recalling whether they received a letter (e.g., Totzkay, Thomas et al., 2018). It is also assumed women in states with active legislation would have had to receive a notification letter, while women in states without the legislation would not have received a letter. Then, a second study samples the same population of women to test the effects of a hypothetical notification letter, measuring EPPM constructs and breast density knowledge to assess the motivational and educational potential of the notification letters. In the following section, the findings of these two studies are highlighted and discussed further.

Summary of Findings

In Study 1, it was observed that women in states with and without legislation mandating breast density notification largely did not differ in their breast density knowledge. While there was one difference, it was only that women in states without mandated notification more strongly believed dense breast tissue complicated mammogram interpretation than women in states with legislation. Women appeared to be ambivalent, regardless of legislation status, over whether dense breast tissue can be physically felt, reflecting some uncertainty and misperception observed in qualitative research (e.g., Gunn, Bataglia et al., 2018; Totzkay, Thomas et al., 2018). Otherwise, the sampled women, regardless of legislation status, were generally accurate regarding dense breast tissue complicating mammogram interpretation and there being other options to screen than mammography, as well as dense breast tissue not necessarily indicating cancer.

It was also observed that, contrary to expectations given the goals of breast density notification letters, women in states with legislation did not differ significantly from women in states without it on their reported intention to talk with their respective health care providers about their breast density, nor on reports of perceived self-efficacy and response efficacy. In

other words, even in states without mandated education via post-mammogram letter, women seem to be motivated to talk with their doctors about breast density. While efficacy perceptions appear to predict their intention to do so, the reception of a breast density notification letter does not seem to be necessary for that precautionary motivation process to occur. Given the results of breast density knowledge and motivation across states with and without breast density notification legislation, it may be the case laws are not necessary to educate women; or, there are complementary educational and motivational activities in place that have not been well-documented in scholarly work. However, this explanation does not address the motivational potential of the notification letters themselves, which was explored in Study 2.

The primary implication from Study 2 is that notification letters may initiate a precautionary process, as intended. Indeed, this study found, following the reading of a hypothetical notification letter, women reported significant perceptions of comparative risk severity, comparative risk likelihood, worry about the risk, feeling vulnerability to the risk, self-efficacy and response efficacy about the precautionary behavior of talking to one's health care provider, and intention to bring breast density information to their health care provider. It was also the case that women mostly reported significant, accurate breast density knowledge after reading the hypothetical notification, regardless of legislation status in their state.

Study 2 did find some differences in post-notification reports based on states. Namely, it was observed that women in states without notification legislation perceived greater self-efficacy regarding breast density talk with their health care provider than women in states with legislation. Perhaps after reading a notification letter, women who were not likely to have been sent such a letter after their mammogram reported more capability to talk with their health care provider than women who were likely to have been sent such a letter. In other words, the notification letter might be more effective in promoting efficacy in its initial receipt rather than

subsequent ones. It was also the case in these data that women from states with legislation mandating breast density notification reported a nonsignificant belief that dense breast tissue can be physically felt. Though the data trended in the expected direction of accurately believing this is not the case, the average response did not differ from ambivalence. If this is indeed the case and not simply an artifact of this study's measurements and sampling, it might be that there are competing messages about breast density in these states that make respondents unsure of the implications of breast density. These messages could be resulting from interpersonal sources who have also received breast density messages or other longer-term sense-making that is taking place as a reaction to this information being disseminated.

Lastly, Study 2 found a complex dynamic within the EPPM and its proposed expansions. While intention to talk with one's health care provider about breast density was indeed predicted, the tested mechanisms presented a more complicated picture. Namely, outside of efficacy perceptions, worry about breast density was the only risk-related predictor of intention. While this is contrary to more contemporary theorizing around the EPPM (Popova, 2012; Shen & Dillard, 2014), it was observed that perceived risk severity and feelings of vulnerability may influence intention through their effect on worry. Additionally, contrary to original EPPM theorizing (e.g., Witte, 1992), the more deliberative assessment of risk likelihood did not have a direct nor an indirect effect on intention. Instead, more intuitive assessments statistically predicted intention to enact the precautionary behavior in question. These data suggest women do not necessarily think breast density increases the likelihood or probability of developing breast cancer, but still *feel* as though they might be more likely or more *vulnerable* because of it. Instead of a more logical assessment of risk, it appears in these data that a more affective assessment of one's feeling vulnerable to a risk may elicit an affective-cognitive feeling of worry. This experience of worry, then, is what might predict behavior. This could suggest

models like fuzzy trace theory (Reyna, 2005) are more accurate in the proposition that broader, more intuitive assessments of risk predict behavior. It could also be that the affect-oriented risk assessments are more predictive of an experience like worry, while more logical or deliberative assessments are more predictive of experiences like fear, which would be more in line with the original conceptualization of the EPPM.

In all, it appears women in these samples largely understand breast density, though not comprehensively. Women in these samples were motivated to talk with their health care provider about breast density; and, the mandated breast density notification letters might succeed in educating and motivated women. However, there are some complications for specific aspects of breast density knowledge. There also is some indication that either breast density notification letters are not necessary or that other educational activities are in place that provide similar information about breast density. These findings are discussed in the following section as they relate to breast density notification, clinical decision-making, and theorizing around the EPPM.

Implications for Breast Density

Given the pattern of results in this dissertation, some evaluation of breast density legislation is warranted. In addition to that, a more nuanced understanding of how the women think about and use breast density information is needed to better explore the clinical implications of breast density information being widely disseminated. These points are considered next.

Breast density legislation. The intention behind breast density notification laws is to educate women about their breast anatomy and, with it, awareness of mammography's limitations (Molleran, 2014; O'Neill et al., 2014). In doing so, the letters are then intended to spur conversation between the woman and her health care provider about her dense breast tissue and what that means for her health care decision making. Some research has been conducted to

assess whether these notification succeed in this, but this tends to be qualitative and draw samples from small regions. Typically, these studies have found most sampled women state they understand breast density and most intend to talk with their health care providers about their own breast density. However, less has been done to assess how much of this is due to breast density notifications.

In this study, a similar pattern of results to past studies was found in that women appeared to understand breast density. However, the current approach was different from past studies that asked women to define their understanding of breast density (Rhodes, Breitkopf, Ziegenfuss, Jenkins, & Vachon, 2015). Instead of explaining breast density in response to a qualitative open response question, women in this study reported their agreement to accurate and inaccurate statements about breast density. These statements were either parallel to the goals of breast density notification laws (e.g., dense tissue complicates mammogram interpretation, other options than mammography are available) or created from documented misperceptions (e.g., dense tissue means cancer is present, dense tissue can be physically felt; Totzkay, Thomas et al., 2018). While this approach is still a directed recall that may be susceptible to demand characteristics (Nichols & Maner, 2008), it begins to explore specific intentional and unintentional knowledge outcomes of breast density notification letters. Using this approach, this dissertation found women were mostly accurate in their reports on breast density knowledge statements. While past studies found some women may believe having dense breast tissue meant they have cancer (e.g., Gunn, Bataglia et al., 2018), the sampled women here generally believed this was not the case. There was also a relatively strong reported belief, correctly so, that dense breast tissue complicated mammogram interpretation. Both of these findings were especially the case immediately following the reading of a breast density notification, but they still held true for women cross-sectionally without exposure to a notification letter. There was also an average,

statistically significant belief that other options than mammography were available both after viewing a notification letter and cross-sectionally.

Despite findings generally being in the predicted directions, one breast density knowledge report was not. It appears the misperception that dense breast tissue can be physically felt may be persistent, as was documented in past qualitative research (Gunn, Bataglia et al, 2018; Totzkay, Thomas et al., 2018). While women in this study trended toward an accurate belief that dense breast tissue cannot be felt, the average of these reports and the respective 95% confidence interval were close to the scale midpoint (i.e., ambivalence) and, in some cases, did not significantly differ from the midpoint. This means that women may hold accurate beliefs about breast density, but they might not be strongly held. If accurate knowledge is indeed an objective of breast density information initiatives, strategic messaging ought to address this potential issue. Questions remain about what source or sources are providing messages to influence women's beliefs that dense tissue can be physically felt. It may be the case that health care providers or some other health information source are conflating dense breast tissue with a phenomenon known as *fibrocystic breasts.*

As explained in Study 1's discussion, fibrocystic breasts result from breast tissue changes that create cysts or areas of fibrous tissue in the breast (American Cancer Society, 2018b). Fibrocystic breasts and dense breast tissue are similar in some regards, namely that they both can obscure mammogram interpretation. Despite these similarities, they are distinct (DenseBreast-Info, Inc., 2018a); dense breast tissue can only be observed and classified when reviewing a woman's mammogram, while the condition of having fibrocystic breasts can be physically observed and identified (see Freer, 2015; Smith, 2013). Given a documented confusion among health care providers regarding dense breast tissue (Gunn, Kressin et al., 2018), it may be the case that health care providers are erroneously communicating information about fibrocystic

breasts as information on dense breast tissue; or alternatively, women might be conflating the two health conditions. At any rate, these quantitative data provide further evidence to suggest the prevalence of this misunderstanding and indicate that research ought to explore what source or sources may be responsible for women's confusion. Perhaps more directed interview studies with health care providers to explore their understanding of breast density and potential conflating with fibrocystic breasts are warranted, along with content analyses of text and video news stories that might discuss either phenomenon. Adherence to the mandated notification language and the nature and impact of any variation in such should be documented, as no study has explored this, despite adaptation being intrinsic to the adoption of innovations (Dearing, Smith, Larson, & Estabrooks, 2013). Also, younger generations increasingly often do not have primary health care providers (Kirzinger, Muñana, & Brodie, 2018), and may rely on specialists or newer retail clinics (Rand Corporation, 2016). Thus, communication research needs to better explore the reality of health care decision making outside of the traditional doctor-patient encounters in general, but especially in the exploration of where breast density information originates.

Breast density clinical decision-making. Outside of increasing breast density knowledge, the objective of breast density notifications is to influence health care communication and decision making. Namely, notifications are intended to motivate women to bring their breast density information to their health care providers (Molleran, 2014). However, it does not seem to be the case that notifications are necessary to do this. In this dissertation, no motivational differences arose between women who would have and would not have received a breast density notification letter, with the entire sample's average being in the positive direction. This means women, regardless of whether they have or have not received a notification, feel capable of bringing the information to their health care provider and intend to do so. There was,

however, a difference in perceived self-efficacy for talking with one's health care provider after viewing a sample notification letter (Study 2), such that women in states without legislation actually reported higher self-efficacy after reading the breast density notification. It could be that women in states with legislation had viewed the notification previously, so its induction was not as powerful due to a lack of novelty in the message. If this is the case, it would suggest notifications do indeed have the power to induce perceptions of self-efficacy in women who receive them, evidenced here by women who purportedly see the notifications for the first time being more strongly induced than women who had seen them previously.

A past concern by skeptics of breast density notification legislation is that notifications cause unnecessary concern or worry (e.g., Rey, Price, & Joe, 2014). However, this was only speculation or perhaps anecdotal. The present data do suggest this may be an accurate assessment because participants indeed are worried about breast density after reading a notification letter. However, this may actually be beneficial. These data only capture a direct self-report of whether participants were worried and not the reasons behind that worry, but they still suggest worry may motivate precautionary behavior. These data, however, cannot speak to whether this worry is prolonged nor if it results in any specific maladaptive outcome. Future work and discussion about breast density ought to at a minimum recognize notification letters' persuasive potential for motivating patient engagement.

Overall, these data provide a tentative indication of the motivational potential of breast density notification letters. It appears they motivate women to talk to their health care provider about breast density, as seen in previous studies (e.g., Manning et al., 2017), but different from those studies here is that the construct of perceived likelihood did not play a significant role in predicting an outcome like intention. In these data, perceived likelihood did not appear to be induced by the notification nor did it statistically predict worry and intention. As will be

discussed in the proceeding section, this may have implications for theory, but in a practical sense, it might be that there is not sufficient information to affect this deliberative judgement in the notification letter. There appears to be more affect-related information conveyed, given that worry and feelings of vulnerability appear to be induced, but more rational judgements of the probability of risk are apparently not as influenced. It is also the case that the design used in both studies of this dissertation does not allow for an explicit measure of whether or not constructs are induced since a true experimental design was not employed. This precludes a true assessment of induction of any construct. Future studies should attempt a traditional experimental design with a true non-treatment control group to examine effects of density notifications.

Implications for the EPPM and Communication Science

In addition to exploring questions of public health related to breast density, this dissertation also addressed conceptual clarity and utility of the EPPM. Specifically, the central category of perceived threat in the EPPM was addressed such that data were collected regarding validity concerns around both perceived severity and susceptibility, as well as to expand perceived threat to include intuitive judgments like feelings of vulnerability and affective judgments like risk-related worry. These data provide clarity on how the EPPM can be modeled in future studies especially in novel contexts like breast density notification.

The data collected in this dissertation show perception of self-efficacy and response efficacy to be the strongest predictors of precautionary behavioral intention, followed by risk-related worry. That worry was the strongest threat-related perception in statistically predicting intention is perhaps not in line with EPPM theorizing; however, it does reflect past experimental and meta-analytic evidence finding worry to be a significant predictor of behavior in experimental studies and to be associated with perceptions of severity and likelihood (Portnoy et al., 2014; Shiloh et al., 2013). It was also found that worry mediated the relationship between

intention and both perceived risk severity and feelings of vulnerability. This observation of an affective response mediating the effect of a threat appraisal on intention is similar to what the EPPM and other related theories predict (e.g., Kahlor, 2010), but also suggests a greater strength of intuitive or affective components of risk. While worry is not necessarily the originally predicted fear response, it does support the contention that an affective response is induced by threat appraisals, which then leads to an increase in intention. This cannot be entirely tested with these data since it is not a true experiment nor are the individual variables in the mediation path induced separately. However, it does provide some theoretical support for including worry alongside the other threat components.

Given that the deliberative assessment of perceived risk likelihood did not predict intention directly nor indirectly while controlling for more intuitive assessments suggests support for models giving affect and intuition a more central role. Models such as fuzzy trace theory (Reyna, 2005) suggest an individual's gut reaction or intuitive reasoning is more predictive of motivation and behavior than a rational assessment of whether a risk with affect them and whether that would bring serious consequences. More data are needed to comprehensively assess this, given that most comparison is theoretical and studies have largely not been designed to directly compare them. This conclusion is also necessarily tentative as perceived risk likelihood does not appear to have been adequately induced by the selected breast density notification letter. A more controlled experimental design with a proper no-treatment control group is necessarily to assess whether these notifications induce perceptions of risk likelihood and, with this or another induction that does adequately induce each relevant construct, whether risk likelihood exerts a significant and substantial statistical effect on behavioral intention.

Another important contribution of this dissertation was to operationalize risk perception within the EPPM not as absolute assessment of a risk's severity and likelihood of affecting an

individual, but instead as comparative with regard to other people and other risks, respectively. Although a direct comparison was not made between absolute and comparative risk perception measures, these data show promise in the use of those comparative assessments especially as no ceiling effect was observed for the perceived severity construct. While the effect of perceived severity weaker than feeling vulnerable to the risk, the use of a comparative operationalization supported theoretical propositions. However, perceived risk severity as a construct has traditionally received limited attention (Shiloh et al., 2013; Weinstein, 2000), and what communication research accepts in theoretical frameworks may be based only on naturally serious threats (e.g., breast cancer) rather than risks that do vary substantially in their perceived harm among the population at risk. Considering risk perceptions as comparative might capture some variance in individuals' perceptions of severity, but does not allow for understanding behavioral dynamics when risks are serious but unlikely, likely but not serious, serious and likely, or unlikely and not serious.

Future Directions

There are a number of opportunities for building upon the results observed in this dissertation. First, continued data collections are needed in states without breast density notification legislation. This will allow for more comparisons across states in the relevant outcome metrics of breast density education initiatives. These should include states not sampled in this dissertation. Further, a more controlled experimental design is needed to test the effects of breast density notifications. The studies outlined in this dissertation were not designed with no-treatment control groups, which precludes more confident statements of causality and effect. Additionally, experimental designs can allow for isolation of potentially influential aspects of the notifications and help in making concrete messaging recommendations. For instance, notification letters vary widely in literacy demand (Kressin, Gunn, & Battaglia, 2016), all of which are

considered too challenging for medical texts. An experimental design can examine potential differences in response to notification letters of varied literacy level and how that may interact with women's own individual literacy ability.

Another next step for this research is to explore other sources of breast density information. As discussed, it might be that other sources than a breast density notification letter are disseminating breast density information to patients. As done with other breast cancer information in the past (Atkin et al., 2008; Totzkay, Walling, Silk, & Smith, 2018), breast density information can be searched for in news publications and relevant websites to examine if and how information related to breast density might be presented to women. Similarly, the information on breast density presented to health care providers should be examined, especially given that they tend to be confused about breast density (Mirghani et al., 2017). It does not appear that an assessment has been made of what medical education on this topic is available to providers nor a more nuanced exploration of their beliefs around the topic. If what this dissertation suggests about providers blending density and fibrocystic breasts is to be explored, for example, direct study of providers' beliefs and understanding of the phenomena needs to be done.

Additionally, while this dissertation suggests responses to notifications like worry or anxiety might actually be adaptive responses, other consequences of that response should be studied. For instance, as noted in the literature review, opponents of breast density notification legislation claim notifications and their affective responses will limit patient attention to other more prominent breast cancer risk factors (Haas & Kaplan, 2015; Klinger et al., 2016; Rey, Price, & Joe, 2015). Quantitative social science research can explore this by examining whether and by what degree women discount other risk factors after learning about breast density, as well

as explore if learning about breast density alters their decision-making regarding other breast cancer-related clinical decisions and procedures.

There are also additional routes that can be explored regarding communication science and risk perception theorizing. Given the nonsignificant results for perceived comparative risk likelihood in this study, additional experimental evidence should be pursued with different operationalizations of this construct. The present results can only be taken tentatively, so more evidence should be gathered before making larger claims regarding deliberative versus intuitive risk responses. Likewise, a greater focus in risk perception research should shift to a message design rather than message effects paradigm (O'Keefe, 2003). Indeed, the EPPM suggests *vivid* language be used to induce severity and susceptibility (likelihood) perceptions (Maloney, Lapinski, & Witte, 2011). Message vividness refers to the extent language evokes imagery, is detailed and concrete, and is emotionally interesting (Dillard, 2014; Hosman, 2002; Nisbett & Ross, 1980). Closer inspection of this definition shows that concreteness is the only message *design* aspect of this definition, as both the evocation of imagery and the emotionality of a message are squarely under the category of message *effects* (Dillard, 2014; O'Keefe, 2003).

Concrete language draws attention to local and specific details of a message (Stapel & Semin, 2007), which drives specific actions that can reduce or avoid risk while not leaving any action plan up to interpretation. Abstract language can result in more uncertainty and more disputing of message claims (Semin & Fiedler, 1988), while concrete language has been suggested to increase perceptions of information utility and be more directive of behavior (Fiedler, 2008). Lastly, concrete language may also bring abstract, potentially hypothetical or low-likelihood risks closer psychologically (Liberman & Trope, 2008), thus increasing the salience of the risk and potentially leading to increased motivation to protect against it. This last point is especially relevant to breast cancer communication research, given that the disease tends

to be seen as psychologically distant (Neuberger et al., 2011). Overall, more concrete language in a risk message should then increase the likelihood that participants incorporate the easier-to-visualize information into memory and relevant cognitive systems for their assessment of, for example, breast cancer risk. This can be explored in the context of breast density, as well, given past qualitative work suggesting women find the notifications to be vague or unhelpful (Gunn, Bataglia et al., 2018).

Limitations

This dissertation is not without limitations. Namely, the unequal distribution of participants across an already limited number of states drawn from prevents extensive generalization of results. Analysis could not be adequately powered to provide greater nuance to differences in perceptions and knowledge scores to examine whether the patterns observed were truly attributed to states with and without legislation, in general, or only to the states that were overrepresented here.

Further, given the construction of Study 2's scale items meant to more finely measure risk perception that were specific to the message induction, a non-treatment control group who answered identical questions could not be used. This prevents stronger claims about the breast density message, which was only an exemplar of the distribution of breast density messages. This dissertation used one study that could not guarantee participants had or had not received a breast density notification letter (Study 1) and was primarily hypothetical (Study 2). Variation exists among the mandated notification legislation, so these messages may differently influence message outcomes and claims made in this dissertation cannot be extended to those messages. There is also likely a different response from women who truly have received these letters in real-time compared to the hypothetical scenario in this dissertation, so claims made regarding the effect, or lack thereof, of breast density notification letters are necessarily tentative.

The responses gathered in these data are also necessarily a convenience sample, which prevents this dissertation from generalizing to more diverse populations. Only those women who have been enrolled in Qualtrics's panel service were eligible to take this survey, which fundamentally limits the overall study population. There was no guarantee that these women were representative of all U.S. women who may receive a breast density notification. Additionally, stronger checks can be employed to ensure participants did not retake the survey multiple times to meet the inclusion criteria falsely.

CHAPTER 9

Conclusion

The extent of public understanding of breast density and the role played by breast density notification letters remain uncertain. In some ways, women seem to generally understand what breast density is and how it affects their health care decision making. In other ways, some misunderstandings about it appear to be pervasive and it is unclear what sources of relevant information women are being used to shape those beliefs. Regardless, communication science provides useful frameworks to explore these and related phenomena while also testing novel and necessary theoretical innovations. In this vein, theorizing specifically around the EPPM was addressed and these data indicate some research questions need to be further investigated to provide more clarity. It does appear that risk perception constructs traditionally used by communication researchers employing the EPPM may have suffered validity limitations and there may be a unique dynamic occurring. It might be that affective responses to risk are more influential than deliberative and rational responses, but that does not preclude their influence. Future studies need to continue to apply innovations from risk perception and decision science research to challenge not only the theoretical integrity of frameworks common to communication science, but also to address how necessary and applicable these innovations are for communication research. In doing so, myriad theoretical accounts of individuals' responses to risk messages can be streamlined while also addressing matters of public health importance.

APPENDIX

Mammography Lay Letter Template (adapted from American College of Radiology, 2018b) with New York Breast Density Notification Text

Dear Patient,

We are pleased to let you know that the results of your recent mammogram shows no sign of breast cancer.

Even though mammograms are the best method we have for early detection, not all cancers are found with mammograms. If you feel a lump or have any other reasons for concern, you should tell your health care provider.

Your mammogram shows that your breast tissue is dense. Dense breast tissue is very common and not abnormal. However, dense breast tissue can make it harder to find cancer on a mammogram and may also be associated with an increased risk of breast cancer. This information about the result of your mammogram is given to you to raise your awareness. Use this information to talk to your doctor about your own risks for breast cancer. At that time, ask your doctor if more screening tests might be useful, based on your risk. A report of your results was sent to your physician.

Your images will become part of your medical record at our facility. They will be on file for your ongoing care. If, in the future, you change health care providers or go to a different location for a mammogram, you should tell them where and when this mammogram was done.

Thank you for allowing us to help meet your health care needs.

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