



# Between-race differences in the effects of breast density information and information about new imaging technology on breast-health decision-making



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## ABSTRACT

**Objectives:** Some US states have mandated that women be informed when they have dense breasts; however, little is known about how general knowledge about breast density (BD) affects related health decision-making. We examined the effects of BD information and imaging technology information on 138 African–American (AA) and European–American (EA) women's intentions to discuss breast cancer screening with their physicians.

**Methods:** Women were randomly assigned to receive BD information and/or imaging technology information via 2 by 2 factorial design, and completed planned behavior measures (e.g., attitudes, intentions) related to BC screening.

**Results:** Attitudes mediated the effects of BD information, and the mediation was stronger for AA women compared to EA women. Effects were more robust for BD information compared to imaging technology information. Results of moderator analyses revealed suppressor effects of injunctive norms that were moderated by imaging technology information.

**Conclusion:** Information about BD favorably influences women's intentions to engage in relevant breast health behaviors. Stronger attitude mediated-effects for AA women suggest greater scrutiny of BD information.

**Practice implications:** Since BD information may influence women's intentions to discuss BC screening, strategies to effectively present BD information to AA women should be investigated given the likelihood of their increased scrutiny of BD information.

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## 1. Introduction

Women with more dense breasts (i.e., larger ratio of fibroglandular to fatty breast tissue) are at higher risk for breast cancer (BC) [1–5]. Some US states now mandate that, following revelation via mammogram, women with dense breasts be notified of their breast density (BD) and associated BC risk [6,7]. Consequently, and in light of women's generally inaccurate knowledge about what BD is [8], we must clarify how generally educating women about BD and the associated BC risk influences their decision-making related to breast health behaviors (e.g., decisions about BC screening). Given that dense breasts mask tumors on mammograms [9], it is also worthwhile to simultaneously examine how learning about new breast imaging modalities that may be better suited for

imaging dense breasts (i.e., ultrasound tomography [UST]) affects women's behavioral decision-making. We used the theory of planned behavior (TPB) [10,11] as a model to examine effects of BD and UST information on BC screening decision-making.

The TPB is a well-validated cognitive-process model which has been used successfully in the prediction of health behaviors [12,13] and which theorizes a specific role for information. In the TPB, behavioral intentions directly predict behavioral engagement, and are themselves directly predicted by attitude towards the behavior, perceptions of descriptive norms (what you see others doing) and injunctive norms (what you think others want you to do), and perceptions of behavioral control (PBC). In turn, attitudes, norms and PBC are influenced respectively by beliefs about behavioral outcomes, motivations to comply with and pay attention to relevant others and beliefs about behavioral impediments. The TPB proposes that knowledge and information are background factors that (a) influence attitudes, norms and PBC indirectly by making related beliefs more salient and (b) influence the magnitude of the relation between attitudes, norms and PBC and subsequent

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behavioral intentions [14,15]. For example, BD risk information may make beliefs that “breast cancer screening saves lives” more salient, both engendering more favorable attitudes towards BC screening and increasing reliance on those attitudes for the formation of BC screening intentions. Thus, the mediational role of attitudes underscores their importance for cognitive integration of health information, and the moderating role of health information underscores the important role that information plays in anchoring decision-making to relevant beliefs and attitudes.

The influence of relevant information may be different for African American (AA) and European American (EA) women. We generally expect the effect of BD information to be greater for EA women compared to AA women since BD information may not be as effectively received by AA women in the absence of culturally targeted dissemination [e.g.,16–18]. This suggests that for AA women we may find a weaker effect of BD information on intentions and attitudes, a weaker mediated effect of BD information on intentions, and a weaker moderating effect of BD information on the relation between attitudes and intentions.

Data show that breast ultrasound identifies additional breast cancers that have been missed by mammograms among women with dense breasts [19–23], and the application of automated whole breast ultrasound imaging [24–26] makes it feasible that this modality may one day be introduced as a screening tool for women with dense breasts. Consequently, it is worthwhile to understand how making women aware of this technology will influence their decision-making. Compared to BD information, information about new medical technology is more saliently related to medical institutions. Given extant evidence of medical mistrust among AAs [27–29], information about new medical technology may also make some unfavorable beliefs more salient; so much so that they may attenuate any positive effects of new technology information on attitudes and intentions for AA women. Hence, we expect new technology information to lead to stronger intentions, for that effect to be more strongly mediated, and for technology information to be a stronger moderator for EA women compared to AA women.

### 1.1. Current study

Guided by the TPB, we tested hypotheses that information about BD and information about new imaging technology (breast UST via Softvue™) [24] would increase women’s intentions to talk to physicians about BC screening. We expected information to most strongly affect attitudes; thus, attitudes should most strongly mediate the effects of, and be moderated by, information as it influences intentions. We expected our hypothesized effects to be weaker for AA women compared to EA women.

## 2. Methods

### 2.1. Participants and procedure

Two hundred and two AA or EA women older than 40 were recruited via SurveyMonkey to participate in our study online examining how BD information affects anxiety related to learning one’s BD. Information on how respondents are recruited to and compensated by SurveyMonkey is available here: [www.surveymonkey.com/mp/audience](http://www.surveymonkey.com/mp/audience). Since our current analyses examined the effects of BD information on decision-making processes related to discussing screening behaviors with physicians, and since women who already knew their BD may have separate but related beliefs that influence their screening decisions, we restricted our analysis to those women ( $N=138$ ) who reported that they did not know their own BD. We used a 2 (BD Information) by 2 (UST Information) between-subjects factorial design. Upon consenting

to participate, women provided demographic information and responded to items assessing BD knowledge (including whether they knew their own BD). They were then randomly assigned to one of four information conditions: no information, BD information, UST information or both information types. Following exposure to information, they completed planned behavior items related to talking to their doctors about BC screening. They also completed other cancer-related perceptions items (e.g., BC risk knowledge, cancer history, etc.) not reported here. Our study protocol was approved by our institutional review board.

### 2.2. Information conditions

Participants in the BD information condition viewed a title slide (“Breast Density”) and three slides of information related to breast density (Fig. 1a). Participants in the UST information condition viewed a title slide (“Advances in Breast Imaging Technology”) and three slides of information related to Softvue™ (Fig. 1b). Participants in the both information condition viewed a title slide (“Breast Density and Advances in Breast Imaging Technology”) followed by the three BD information slides and the three UST information slides. Participants in the no information condition did not receive any information.

### 2.3. Measures

**Theory of Planned Behavior Items.** Our target behavior was discussing BC screening with one’s doctor (i.e., “. . . talking to my doctor [i.e., primary care, ob/gyn, etc.] at my next available appointment about being screened for breast cancer”). All responses were on a scale from 1 to 7, with some responses reverse coded to address response bias. There was missing data for some scale items due to skipped responses. We established scale reliabilities with raw item scores and imputed missing data for the aggregated scale scores (imputation methods described below). Participants indicated intentions with responses to two items (e.g., “I intend to talk to my doctor . . .”, and “I have decided that I will talk to my doctor . . .”). Item correlation was acceptable ( $r=.81$ ,  $n=134$ ,  $p<.001$ ) and the mean was used to assess intentions. Attitudes were assessed with the mean of participants’ responses to 5 items regarding attitudes (e.g., Extremely pleasant/extremely unpleasant, beneficial/harmful) towards discussing BC Screening ( $\alpha=.84$ ,  $n=130$ ). Injunctive norms (i.e., “Most people I care about would expect me to talk to my doctor . . .”) descriptive norms (i.e., “Most women who I care about would talk to their doctor . . .”) and PBC were each assessed with one item (e.g., “For me to talk to my doctor . . . is <extremely easy to extremely difficult>”).

### 2.4. Statistical analyses

To address missing data, we used SPSS v. 20 to impute 5 sets of complete data using Markov Chain Monte Carlo algorithms with linear regression models for the estimation of continuous variables, and used the mean across the imputed data for analyses.

We used a 2 (BD information) by 2 (UST information) by 2 (Race) full-factorial MANOVA to examine experimental effects and between-race differences in experimental effects on intentions and on the predictors of intentions.

To examine our mediation and moderation hypotheses, we fit multi-group path models, with race as the grouping factor, using lavaan [30] implemented with R software v 3.1.2 [31]. The mediation model (Fig. 2) was specified such that intentions, attitudes, injunctive and descriptive norms, and PBC were endogenous variables, each predicted by two effects-coded variables to identify receipt of UST or BD information (coded as .5 for Yes,  $-.5$  for No), and their interaction. Covariances were

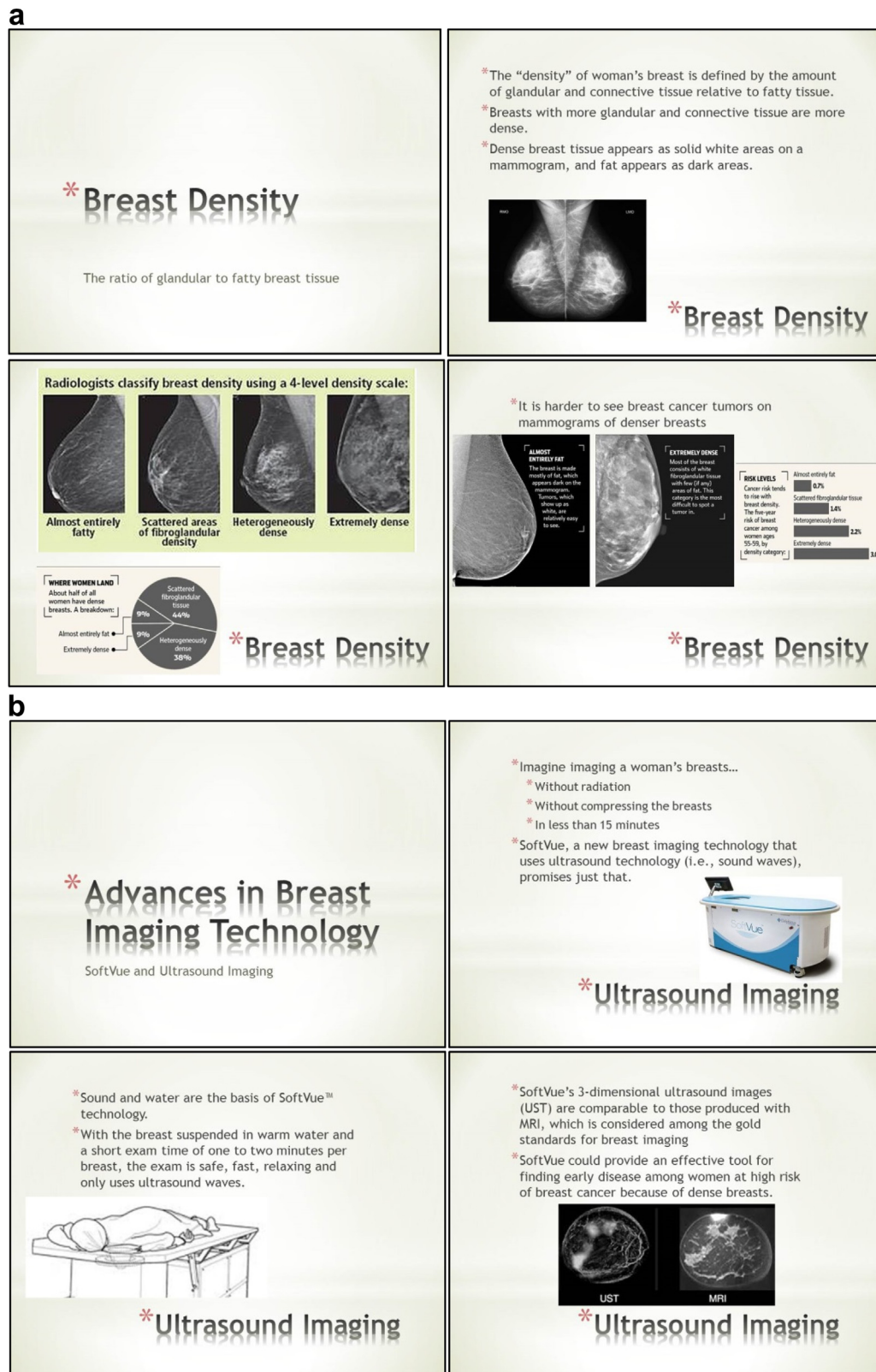
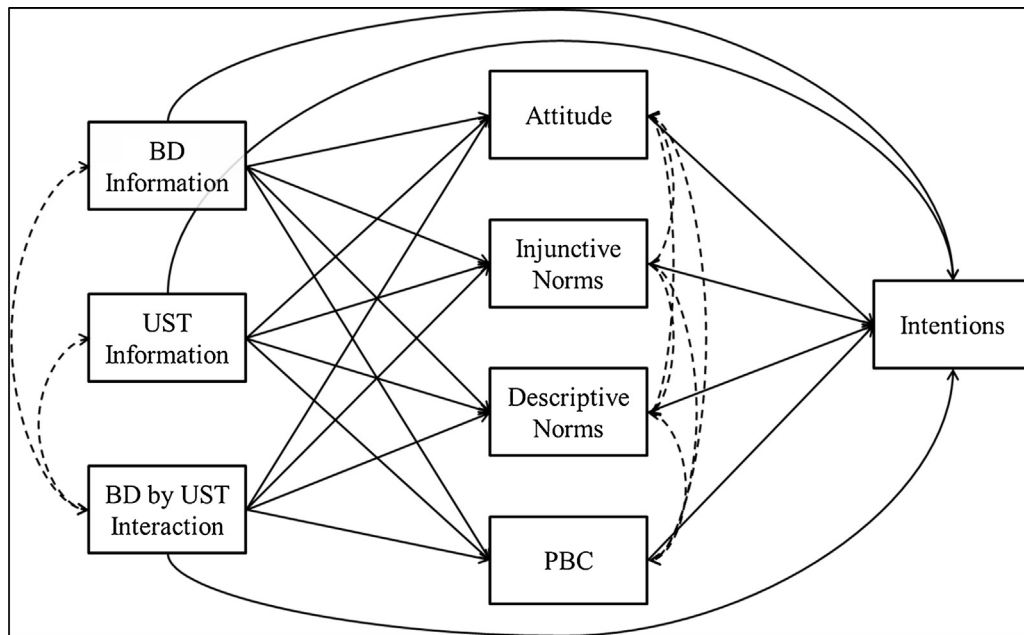


Fig. 1. (a) Breast density information condition slides. (b) Ultrasound tomography information condition slides.

specified from each condition to the interaction term. Among endogenous variables, predictive paths were specified from attitudes, norms and PBC to intentions, and residual correlations were specified among the endogenous predictors of intentions. We first fit an invariant model in which all parameters (intercepts and

path coefficients [PC]), except exogenous covariances, were constrained to be equivalent between races, followed by a variant model in which all parameters were freely estimated. Significant improvement in model fit is taken as evidence that the parameter estimates vary between race.



**Fig. 2.** Path diagram for mediation model. Solid unidirectional arrows indicate predictive paths; dashed bidirectional arrows indicate exogenous covariance/endogenous correlated residuals. PBC, perceived behavioral control; BD, breast density; UST, ultrasound tomography.

The moderation model was specified such that behavioral intentions was the sole endogenous variable, and was predicted by the main effects and interaction for information conditions, main effects of TPB predictors of intention, and interactions between TPB predictors and the experimental conditions. For ease of interpretation, the TPB predictors were standardized within race before the interaction terms were constructed. Given the size of the path models and concerns about sample size and parameter reliability, we used preliminary OLS regressions to guide selection of TPB predictor by condition interactions to include in our final model.<sup>1</sup> Where interactions were significant, we probed them with methods outlined by Preacher et al. [32].

### 3. Results

#### 3.1. Sample characteristics

Before restricting our sample for analyses, we checked the full sample ( $N=202$ ) to see whether there was a significant between-race difference in the proportion of women who did not know their own BD—chi-square analysis indicated no significant between-race difference. Our restricted sample for analyses consisted of 67 AA women and 71 EA women, most in the 55–60 age group (26.8%: range = “41–44” [8%] to “75 and older” [1.4%]). There was no between-race difference in age group. There was no between-race

difference in the fifteen out of 123 women who indicated that had never had a mammogram; however, of 107 item respondents, more EA than AA women (30.9% vs. 7.7%) indicated that their most previous mammogram was more than two years prior. (Note: We did not impute missing values for variables used to describe the sample.)

#### 3.2. Experimental effects on BC screen outcome

Results of the MANOVA's multivariate tests indicated that race (Wilk's  $\lambda = .88$ ,  $F_{5,126} = 3.46$ ,  $p < .01$ ,  $\eta^2 = .12$ ) and BD Information (Wilk's  $\lambda = .84$ ,  $F_{5,126} = 4.85$ ,  $p < .01$ ,  $\eta^2 = .16$ ) contributed significantly to the model.

##### 3.2.1. Intentions

Results of between-subject tests indicated significant main effects of BD Information on intentions ( $F_{1,130} = 14.04$ ,  $p < .01$ ,  $\eta^2 = .10$ ). In support of our hypotheses, mean intention in the conditions with BD Information ( $M = 6.16$ ,  $SE = 0.20$ ) was more favorable than mean intention in the conditions without BD information ( $M = 5.10$ ,  $SE = 0.20$ ). The hypothesized BD by race interaction was not supported.

##### 3.2.2. Predictors of intention

**3.2.2.1. Attitude.** There was a significant main effect of BD information on attitudes ( $F_{1,130} = 12.80$ ,  $p < .01$ ,  $\eta^2 = .10$ ). Attitudes were more favorable when women received BD information ( $M = 6.23$ ,  $SE = 0.12$ ) compared to when they did not ( $M = 5.61$ ,  $SE = 0.12$ ).

**3.2.2.2. PBC.** There were significant main effects of BD Information ( $F_{1,130} = 14.80$ ,  $p < .01$ ,  $\eta^2 = .10$ ) and race ( $F_{1,130} = 4.42$ ,  $p < .05$ ,  $\eta^2 = .03$ ) on PBC. Mean PBC was higher when women received BD info ( $M = 6.45$ ,  $SE = 0.19$  vs.  $M = 5.45$ ,  $SE = 0.18$ ) and among AA women ( $M = 6.22$ ,  $SE = 0.19$ ) compared to EA women ( $M = 5.67$ ,  $SE = 0.18$ ).

<sup>1</sup> We used 4 separate OLS regressions each for AA and EA women to examine whether the information conditions affected the relation between cognitive information and intentions differently for EA and AA women—each regression tested for an interaction between a focal TPB predictor and the information conditions. For example, to examine whether there were any effects of condition on the relation between attitudes and intentions, we included three 2-way interactions (Attitude by UST Information; Attitude by BD Information; UST by BD Information) and one 3-way interaction (Attitude by UST by BD Information). We entered variables into the regression equation in two steps: on step one, we entered the information condition main effects and interactions and the TPB main effects; on step two, we entered the TPB predictor by condition 2-way and 3-way interactions. Because we were performing four separate tests for women in the sample, we adjusted the Type-I error rate to reflect multiple tests ( $.05/4 = .0125$ ).

3.2.2.3. *Descriptive norms.* There was neither significant race nor condition effects on perceptions of descriptive norms.

3.2.2.4. *Injunctive norms.* Despite no main effects, there was a significant race by information conditions 3-way interaction on injunctive norms ( $F_{1,130} = 6.97, p < .01, \eta^2 = 0.05$ ). We probed this interaction with 2 (BD Information)  $\times$  2 (UST information) ANOVAs separately by race. There were no significant main effects of, or interactions between information conditions for EA women. For AA women there was a significant interaction between UST and BD information ( $F_{1,63} = 7.04, p < .05, \eta^2 = 0.10$ ). When AA women got no BD information, UST information yielded lower injunctive norms ( $M = 4.49, SE = 0.46$  vs.  $M = 5.74, SE = 0.45$ ). When AA women received BD information, UST information yielded higher injunctive norms ( $M = 5.75, SE = 0.49$  vs.  $M = 4.43, SE = 0.53$ ).

### 3.2.3. Predicting intentions

3.2.3.1. *Mediation hypothesis.* Model comparison test indicated that the data was a better fit to the variant model ( $\Delta c^2(5) = 17.99, p < .01$ ), suggesting that the path coefficients were not equivalent between AA and EA women. Model fit indices are not meaningful for the variant model because it was fully saturated; therefore we interpret the estimated coefficient of determination for intentions (i.e.,  $R^2$ ) as an alternative measure of fit. The model accounted for 50% and 57% of the variance in intentions respectively for EA women and AA women. Path coefficients are presented in Table 1. Noteworthy differences between path coefficients for AA and EA women include a direct effect of BD information on BC screening intentions for EA women ( $0.66, p < .05$ ) with no corresponding direct effect for AA women; a significant effect of BD information on attitudes for AA women ( $0.82, p < .05$ ) vs. a marginal effect for EA women ( $0.43, p < .10$ ); and, similar to the results from the

**Table 1**  
Path coefficients for model testing mediation hypothesis.

Outcome	European-Americans		African-Americans	
	Path coefficient	SE	Path coefficient	SE
<b>Intention</b>				
Attitude	1.14 <sup>a</sup>	0.19	0.80 <sup>a</sup>	0.27
Inj norms	-0.05	0.10	0.12	0.10
Desc norms	0.05	0.09	-0.03	0.10
PBC	-0.09	0.11	0.27	0.17
BD info	0.66 <sup>b</sup>	0.28	0.08	0.33
UST info	0.12	0.27	0.24	0.29
BD*US info	-0.06	0.54	-0.66	0.62
<b>Attitude</b>				
BD info	0.43 <sup>c</sup>	0.23	0.82 <sup>a</sup>	0.25
UST info	0.02	0.23	-0.27	0.25
BD*US info	-0.34	0.45	0.64	0.51
<b>Inj norms</b>				
BD info	0.12	0.39	-0.02	0.47
UST info	0.35	0.39	0.04	0.47
BD*US info	-0.72	0.77	2.57 <sup>a</sup>	0.94
<b>Desc norms</b>				
BD info	0.50	0.40	0.61	0.43
UST info	0.47	0.40	-0.28	0.43
BD*US info	-0.61	0.80	-0.52	0.85
<b>PBC</b>				
BD info	0.82 <sup>b</sup>	0.38	1.18 <sup>a</sup>	0.33
UST info	0.08	0.38	-0.44	0.33
BD*US info	-0.62	0.75	0.40	0.67

Notes: BD, breast density; UST, ultrasound tomography; Inj, injunctive; Desc, descriptive; PBC, perceived behavioral control.

<sup>a</sup>  $p < .01$ .

<sup>b</sup>  $p < .05$ .

<sup>c</sup>  $p < .10$ .

**Table 2**  
Path coefficients for model testing moderation hypothesis.

	European-Americans		African-American	
	Path coefficients	SE	Path coefficients	SE
Attitudes	0.76 <sup>a</sup>	0.12	0.65 <sup>a</sup>	0.17
Inj norms	-0.08	0.10	-0.06	0.12
Desc norms	0.01	0.09	-0.08	0.08
PBC	-0.07	0.11	-0.02	0.14
BD info	0.42 <sup>b</sup>	0.17	0.31 <sup>c</sup>	0.17
UST info	0.08	0.17	-0.36 <sup>b</sup>	0.17
BD*UST info	0.08	0.34	-1.09 <sup>a</sup>	0.34
BD*attitude	0.12	0.21	-0.93 <sup>a</sup>	0.32
UST*attitude	-0.31	0.21	0.86 <sup>a</sup>	0.26
BD*UST*attitude	0.26	0.42	2.16 <sup>a</sup>	0.54
BD*inj norms	-0.01	0.19	0.50 <sup>b</sup>	0.25
UST*inj norms	0.39 <sup>b</sup>	0.19	-0.38 <sup>c</sup>	0.22
BD*UST*inj norms	-0.39	0.38	-0.26	0.44

Notes: BD, breast density; UST, ultrasound tomography; Inj, injunctive; Desc, descriptive; PBC, perceived behavioral control.

<sup>a</sup>  $p < .01$ .

<sup>b</sup>  $p < .05$ .

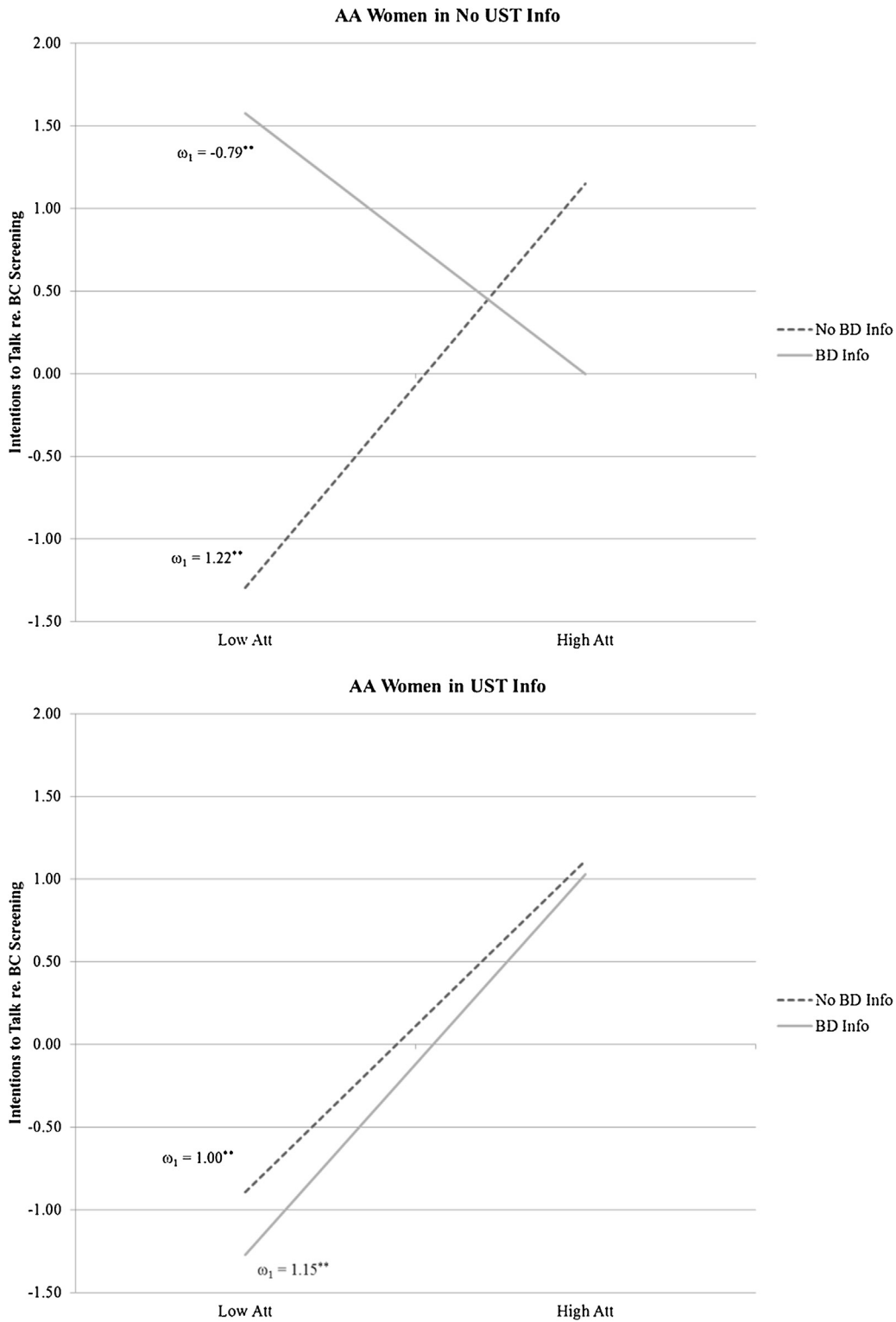
<sup>c</sup>  $p < .10$ .

MANOVA above, a significant effect of the interaction between BD and UST information on injunctive norms for AA women ( $2.57, p < .01$ ), but not EA women.

We estimated each indirect effect (product of path coefficients from the predictor to the mediator [e.g., BD information to attitudes] and from the mediator to the intentions), total indirect effect (sum of all the indirect effects), and total effect (sum of the direct and total indirect effect). Standard errors for each of the effects are approximated via the Delta method [33,34]. For AA women, the total indirect effect of BD was significant ( $0.95, SE = 0.34, p < .01$ ); attitude had the only significant indirect effect ( $0.66, SE = 0.30, p < .05$ ); and the total effect of BD on intentions was significant ( $1.04, SE = 0.84, p < .05$ ). For EA women, the total indirect effect of BD on intentions ( $0.43, SE = 0.25, p < .10$ ) and attitude's indirect effect ( $0.49, SE = 0.27, p < .10$ ) were marginally significant, whereas the total effect of BD on intentions was significant ( $1.09, SE = 0.36, p < .01$ ). These data suggest that, despite equivalent total effects of BD information on BC screening intentions, the attitude mediated pathway was more relevant for AA women than for EA women. Results also indicate that UST information had no overall effect on BC screening intentions.

3.2.3.2. *Moderation hypothesis.* Preliminary OLS regression analyses suggested that there were between-race differences in how information moderated the attitude-intentions and injunctive norms-intentions relations; hence, we conducted our multi-group analyses focusing on those interactions. Model comparisons indicated that the data fit the variant model significantly better than the invariant model ( $\Delta \chi^2(14) = 36.51, p < .01$ ). The model accounted for 73% and 55% of the variance in intentions for AA and EA women respectively. We examine the highest order significant effects for AA and EA women (see Table 2 for path coefficients). For AA women, there was a significant BD by UST by Attitude interaction, and a significant BD by injunctive norms and marginal UST by injunctive norms interaction. For EA women, there were significant main effects of BD information and attitudes, and a significant UST by injunctive norms interaction.

3.2.3.3. *Attitudes.* Results of probing the attitude by condition interactions for AA women indicated a positive association between attitudes and intention unless women received BD



**Fig. 3.** BD information moderation of associations between attitudes and intentions in (1) no UST information condition and (2) UST information condition.

information without UST information (simple slope,  $\omega_1 = -0.79$ ,  $p < .05$ ). The associations are illustrated graphically in Fig. 3. For EA women, attitudes shared a positive association with intentions regardless of information condition (path coefficient = 0.76,  $p < .01$ ).

Since the attitude-intention correlation was negative for AA women who received BD information without UST information ( $r = -.25$ ,  $ns$ ,  $n = 14$ ), we ruled out a suppressor effect explanation for the negative slope. Supplemental analysis revealed significant indirect and total effects of BD information only among AA women

who received UST information, suggesting that negative association between attitudes and intention attenuated the influence of BD information on intentions when AA did not receive UST information.<sup>2</sup>

**3.2.3.4. Injunctive norms.** Though the BD by injunctive norm interaction was significant for AA women, the associations between injunctive norms and intentions were not significant in either condition. There was a negative association between injunctive norms and intentions among EA women who did not receive UST information ( $\omega_1 = -0.28, p < .05$ ) and no association among those who received UST information. Since injunctive norms shared no significant negative bivariate association with behavioral intentions in any condition, this negative association suggests a suppressor effect. We examined the TPB model in separate regressions by condition for EA women, and results suggested that injunctive norms suppressed unexplained variance in the relation between attitudes and intentions. The injunctive norms by UST information interaction was marginally significant in the opposite direction for AA women (see Table 2), suggesting similar suppressor effects for AA women who received UST information—our examination of the TPB regressions by condition for AA women confirmed our expectations.

## 4. Discussion and conclusion

### 4.1. Discussion

We tested the effects of two types of breast-density relevant information and racial group membership on intentions to talk to one's physician about breast cancer screening. We found robust effects for BD information and few effects of UST information. Providing women with general information about what BD is may help to promote their engagement in relevant conversations with their health care providers.

#### 4.1.1. Breast density information

For both AA and EA women, BD information increased intentions to talk to physicians about BC screening, and fostered more positive behavioral attitudes and perceptions of behavioral control. However, it was behavioral attitudes that transmitted the effects of BD information to behavioral intentions. Whereas we expected the effects of BD information on intentions to be weaker for AA women, we found that the total effects were equivalent. Also, the effect was mediated by attitudes more so for AA women, and this mediation was most evident when AA women received concurrent UST information. Altogether, our evidence indicates that racial group membership influences the psychological route

<sup>2</sup> We conducted a supplemental analysis among AA women to examine whether the indirect effect of BD information on intentions revealed via the mediation analysis was significant in both UST conditions while controlling for the moderating effect of BD information on the direct effect of attitudes (i.e., multi-group moderated-mediation with UST condition as grouping variable). We used a statistical model suggested by Hayes [Model 14:45] and fit a path model in which intention was regressed on attitudes, BD information condition and the attitude by BD information interaction, controlling for the remaining TPB predictors. Attitudes, the attitude by BD information interaction and the TPB predictors were in turn regressed on BD information; residual covariance was specified between attitudes and the interaction term. The data fit the variant model significantly better ( $\Delta\chi^2(14) = 36.51, p < .01$ ), and the model accounted for 59% and 74% of the variance in intentions in the no UST and UST information conditions respectively. The conditional indirect effect ( $-0.34, SE = 0.24, ns$ ) and total effect ( $0.42, SE = 0.32, ns$ ) of BD information were not significant among AA women who did not receive UST information; however, they were significant among AA women who received UST information (conditional indirect effect = 1.40,  $SE = 0.48, p < .01$ ; total effect = 1.20,  $SE = 0.48, p < .05$ ).

from information to action in the BD context; however, the actual differences were opposite of those hypothesized.

When it comes to the between-race differences we observed, higher levels of distrust towards medical institutions among AAs [27–29] may provide some explanation. Research indicates that people are more likely to scrutinize messages from sources seen as less trustworthy [35–37]. Though we did not identify medical institutions as the source of BD information, coupling it with information about a new medical device may have made medical institutions more salient, thus leading to greater scrutiny of BD information among AA women, and indirectly linking BD information to intentions via its effects on attitudes. In contrast, BD information directly affected intentions for EA women, with little involvement of behavioral attitudes, likely due to less scrutiny of the information. Also, since the quality of communication between women and their physicians is reportedly better for EA women than AA women [38–41], it may be relatively more difficult to influence EA women's attitudes towards talking to physicians about this topic.

#### 4.1.2. New technology information

In the absence of UST information for EA women, and in the presence of UST information for AA women, there was a suppressor effect of injunctive norms on the relation between attitudes and intentions. Suppressor effects manifest when a suppressor variable (injunctive norms) accounts for more unexplained variance in a separate predictor (attitudes) than in the outcome (intentions). The effect here suggests that attitudes engender stronger intentions, but more so when perceptions of injunctive norms are lower; hence, if two women report similarly favorable attitudes towards talking to their physicians about BC screening, attitudes will have a stronger influence on intentions for the woman who has weaker injunctive norms. For AA women, we noted that attitudes mediated the effects of BD information in the presence of UST information. Consistent with our argument related to medical mistrust, when UST information made medical institutions more salient it may have also made some associated negative beliefs more salient, prompting AA women to consider normative behavioral expectations from pertinent others when forming behavioral intentions, which might be related to increased salience of group norms when group-members are threatened [42]. The reliance on normative information manifested as the suppressor effect on the influence of attitudes. Interestingly, information about medical technology had the opposite effect for EA women in that it cancelled the suppressing effect of normative expectations. More trust in the medical institution may have diminished the influence of normative expectations for EA women when they were presented with UST information. Prior research has demonstrated the suppressing effect of injunctive norms on the influence of descriptive norms in the context of the TPB [43,44]; this current research indicates that the suppressing effect of injunctive norms also extends to the influence of attitudes on subsequent intentions.

#### 4.1.3. Limitations and future directions

There are some limitations to discuss. First, regarding the information manipulation, we kept BD information and UST information distinct; therefore, the condition that received both types of information also received twice as much material (i.e., six vs. three slides of information) in contrast to a three-slide amalgamation of the two types of information. Thus, the content of the presentation is confounded with the length of the presentation, making it difficult to definitively ascertain which contributes to the effects of presenting both types of information. Future research should address this confound, and in doing so researchers may also make a more salient connection between the

new breast imaging technology and its capability to more effectively image dense breasts. Our sample was not large enough to simultaneously test all mediation and moderation hypotheses in a single model. Future research will ensure larger samples with which we may fit more sophisticated path analyses to simultaneously address multiple effects. Future research will also assess actual behavior so that we may understand (a) whether the effects of information on intentions will translate to eventual behavior and (b) how the effects of information decay over time. Future research will also assess the effects of receiving BD notifications (i.e., personal information about one's own BD), and the associated role of existing knowledge about BD, on women's health decision-making. Finally, rather than being the direct cause of an effect or difference in effects, racial group membership should be construed as a proxy for some underlying explanatory socio-demographic (e.g., SES, education, health-care access, etc.) or socio-cultural (e.g., family structure, family communication, race-based medical mistrust, etc.) difference that more directly contributes to observed between-race differences. Future studies that are appropriately powered must examine hypotheses related to underlying variables that may have led to the differences we observed here.

#### 4.2. Conclusions

We present evidence that BD information, in contrast to information about new breast imaging technology, leads to more favorable intentions to discuss BC screening with one's physicians. The effect of information on intentions was mediated more strongly by behavioral attitudes for AA women compared to EA women. The processes and outcomes related to disseminating information about breast density is important as states continue to mandate BD notification and as we continue to educate patients about what BD is, how it relates to BC risk, and what subsequent steps they should take upon receiving notifications.

#### 4.3. Practice implications

The implementation of mandatory BD notification laws obliges educating women about what BD is. Presenting women with BD information will influence relevant downstream behavioral intentions. Strategies to effectively present BD information to AA women should be investigated given the likelihood of their increased scrutiny of BD information.

#### References

- [1] N.F. Boyd, et al., Breast tissue composition and susceptibility to breast cancer, *J. Natl. Cancer Inst.* 102 (16) (2010) 1224–1237.
- [2] N.F. Boyd, et al., Mammographic density and breast cancer risk: current understanding and future prospects, *Breast Cancer Res.* 13 (6) (2011) 223.
- [3] W.E. Barlow, et al., Prospective breast cancer risk prediction model for women undergoing screening mammography, *J. Natl. Cancer Inst.* 98 (17) (2006) 1204–1214.
- [4] C. Byrne, et al., Mammographic features and breast cancer risk: effects with time, age, and menopause status, *J. Natl. Cancer Inst.* 87 (21) (1995) 1622–1629.
- [5] V.A. McCormack, I. dos Santos Silva, Breast density and parenchymal patterns as markers of breast cancer risk: a meta-analysis, *Cancer Epidemiol. Biomarkers Prev.* 15 (6) (2006) 1159–1169.
- [6] D. Grady, New laws add a divisive component to breast screening, *The New York Times*, The New York Times Company, New York, 2012.
- [7] K. Hardy, Breast density notification, *Radiology Today Magazine*, Great Valley Publishing Company, Spring City, PA, 2012.
- [8] M. Manning, et al., Knowledge of breast density and awareness of related breast cancer risk, *J. Cancer Educ.* 7 (2013) p7.
- [9] S.Y.-H. Chiu, et al., Effect of baseline breast density on breast cancer incidence, stage, mortality, and screening parameters: 25-year follow-up of a Swedish mammographic screening, *Cancer Epidemiol. Biomarkers Prev.* (A Publication Of The American Association For Cancer Research, Cosponsored By The American Society Of Preventive Oncology) 19 (5) (2010) 1219–1228.
- [10] I. Ajzen, The theory of planned behavior, *Org. Behav. Hum. Decis. Proces.* 50 (2) (1991) 179–211.
- [11] I. Ajzen, The theory of planned behaviour: reactions and reflections, *Psychol. Health* 26 (9) (2011) 1113–1127.
- [12] M. Conner, P. Sparks, The Theory of Planned Behaviour and Health Behaviours, in *Predicting Health Behaviour: Research and Practice with Social Cognition Models*, in: M. Conner, P. Norman (Eds.), Open University Press, Maidenhead, BRK England, 1996, pp. 121–162.
- [13] W. Hardeman, et al., Application of the theory of planned behaviour in behaviour change interventions: a systematic review, *Psychol. Health* 17 (2) (2002) 123–158.
- [14] I. Ajzen, Martin Fishbein's legacy: the reasoned action approach, *Ann. Am. Acad. Polit. Social Sci.* 640 (1) (2012) 11–27.
- [15] I. Ajzen, D. Albarracín, R. Hornik, Prediction and change of health behavior: Applying the reasoned action approach, Prediction and Change of Health Behavior: Applying the Reasoned Action Approach, Lawrence Erlbaum Associates Publishers, Mahwah, NJ US, 2007.
- [16] M.N. Fouad, et al., Targeted intervention strategies to increase and maintain mammography utilization among African American women, *Am. J. Public Health* 100 (12) (2010) 2526–2531.
- [17] M.A. Garza, et al., A culturally targeted intervention to promote breast cancer screening among low-income women in East Baltimore, Maryland, *Cancer Control J. Moffitt Cancer Center* 12 (Suppl. 2) (2005) 34–41.
- [18] L.M. Gibson, Teaching strategies to facilitate breast cancer screening by African-American women, *J. Natl. Black Nurses' Assoc. JNBNA* 19 (2) (2008) 42–49.
- [19] S. Destounis, A. Arieno, R. Morgan, Initial experience with the new york state breast density inform law at a community-based breast center, *J. Ultrasound Med. Off. J. Am. Inst. Ultrasound Med.* 34 (6) (2015) 993–1000.
- [20] T. Parris, D. Wakefield, H. Frimmer, Real world performance of screening breast ultrasound following enactment of Connecticut Bill 458, *Breast J.* 19 (1) (2013) 64–70.
- [21] J. Weigert, S. Steenbergen, The connecticut experiment: the role of ultrasound in the screening of women with dense breasts, *Breast J.* 18 (6) (2012) 517–522.
- [22] J. Weigert, S. Steenbergen, The connecticut experiments second year: ultrasound in the screening of women with dense breasts, *Breast J.* 21 (2) (2015) 175–180.
- [23] S. Weigel, et al., Digital mammography screening: how many breast cancers are additionally detected by bilateral ultrasound examination during assessment? *Eur. Radiol.* 23 (3) (2013) 684–691.
- [24] N. Duric, et al., Breast density measurements with ultrasound tomography: a comparison with film and digital mammography, *Med. Phys.* 40 (1) (2013) 013501.
- [25] N. Duric, et al., Detection of breast cancer with ultrasound tomography: first results with the computed ultrasound risk evaluation (CURE) prototype, *Med. Phys.* 34 (2) (2007) 773–785.
- [26] B. Ranger, et al., Breast ultrasound tomography versus MRI for clinical display of anatomy and tumor rendering: preliminary results, *AJR Am. J. Roentgenol.* 198 (1) (2012) 233–239.
- [27] L.E. Boulware, et al., Race and trust in the health care system, *Public Health Rep.* (Washington D.C.: 1974) 118 (4) (2003) 358–365.
- [28] J.F. Dovidio, et al., Disparities and distrust: The implications of psychological processes for understanding racial disparities in health and health care, *Social Sci. Med.* 67 (3) (2008) 478–486.
- [29] H.S. Thompson, et al., The group-based medical mistrust scale: psychometric properties and association with breast cancer screening, *Preventive Med.* 38 (2) (2004) 209–218.
- [30] Y. Rosseel, Lavaan: an R package for structural equation modeling, *J. Stat. Software* 48 (2) (2012) 1–36.
- [31] R. Core Team, R: A Language and Environment for Statistical Computing, R Foundation for Statistical Computing, Vienna, Austria, 2014.
- [32] K.J. Preacher, P.J. Curran, D.J. Bauer, Computational tools for probing interactions in multiple linear regression, multilevel modeling, and latent curve analysis, *J. Educ. Behav. Stat.* 31 (3) (2006) 437.
- [33] G.W. Oehlert, A note on the delta method, *The American Statistician* 46 (1) (1992) 27–29.
- [34] Y. Rosseel, The Lavaan Tutorial, Belgium, 2015.
- [35] R.E. Petty, et al., Individual versus group interest violation: surprise as a determinant of argument scrutiny and persuasion, *Social Cognit.* 19 (4) (2001) 418–442.
- [36] R. Ziegler, M. Diehl, Mood and multiple source characteristics: mood congruency of source consensus status and source trustworthiness as determinants of message scrutiny, *Personal. Social Psychol. Bull.* 37 (8) (2011) 1016–1030.
- [37] J.R. Priester, R.E. Petty, The influence of spokesperson trustworthiness on message elaboration, attitude strength, and advertising effectiveness, *J. Consum. Psychol.* 13 (4) (2003) 408–421.
- [38] C.M. Ashton, et al., Racial and ethnic disparities in the use of health services: bias, preferences, or poor communication? *J. Gen. Internal Med.* 18 (2) (2003) 146–152.
- [39] S. Eggy, et al., A disparity of words: racial differences in oncologist-patient communication about clinical trials, *Health Expectations Int. J. Public Participation Health Care Health Policy* (2013).
- [40] R.L. Street Jr., et al., Patient participation in medical consultations: why some patients are more involved than others, *Med. Care* 43 (10) (2005) 960–969.



- [41] L.A. Penner, et al., The experience of discrimination and black–white health disparities in medical care, *J. Black Psychol.* 35 (2) (2009) 180–203.
- [42] H. Tajfel, J.C. Turner, The social identity theory of intergroup behavior, in: J.T. Jost, J. Sidanius (Eds.), *Political Psychology: Key Readings*, Psychology Press, 2004, pp. 276–293.
- [43] M. Manning, The effects of subjective norms on behaviour in the theory of planned behaviour: a meta-analysis, *Br. J. Social Psychol.* 48 (4) (2009) 649–705.
- [44] M. Manning, When we do what we see: the moderating role of social motivation on the relation between subjective norms and behavior in the theory of planned behavior, *Basic Appl. Social Psychol.* 33 (4) (2011) 351–364.
- [45] A.F. Hayes, *Introduction to mediation, moderation, and conditional process analysis: a regression-based approach*, *Methodology in the Social Sciences*, Guilford Press, New York, NY, US, 2013.