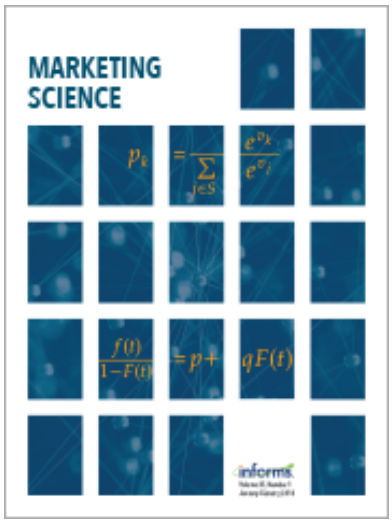


Marketing Science

Publication details, including instructions for authors and subscription information:
http://pubsonline.informs.org

Understanding High-Stakes Consumer Decisions: Mammography Adherence Following False-Alarm Test Results

Barbara E. Kahn, Mary Frances Luce,

To cite this article:
Barbara E. Kahn, Mary Frances Luce, (2003) Understanding High-Stakes Consumer Decisions: Mammography Adherence Following False-Alarm Test Results. Marketing Science 22(3):393-410. https://doi.org/10.1287/mksc.22.3.393.17737

Understanding High-Stakes Consumer Decisions: Mammography Adherence Following False-Alarm Test Results

Barbara E. Kahn • Mary Frances Luce
The Wharton School, University of Pennsylvania, 3730 Walnut Street, Philadelphia, Pennsylvania 19104
kahn@wharton.upenn.edu • luce@wharton.upenn.edu

Consumers often have to decide whether to acquire information in high-stakes decision domains. We study women in mammography waiting rooms to test how a "false-alarm" result (i.e., an indication that a malady is present when a "more accurate" follow-up test reveals it is not) affects willingness to get retested. In Study 1 we show that, given a false-alarm result, life-threatening test consequences are associated with more disutility for future testing than when test consequences are less significant; this does not hold for normal test results. In Study 2 in the mammography context, we show that patients receiving a false-alarm result experienced more stress, were less likely to believe that a positive mammography result indicated cancer, and more likely to delay mammography than patients receiving normal results unless they were also told that they may be vulnerable to breast cancer in the future. We show that delays in planned adherence following a false-alarm result can be mitigated by an information intervention. Finally, we have preliminary evidence that a previous history of false-positive results can cause a consumer to both react more negatively to emotional stress and respond more positively to coping information.
(*Value of Information; Decision Making Under Uncertainty; Medical Decision Making; Stress; Cancer False-Positive; Patient Preferences; Mammography; Medical Testing; High-Stakes Decisions*)

Introduction

Consumer decisions vary considerably in the magnitude of their potential impact. For instance, the impact of choosing the wrong brand of a consumer product is likely to be small, while the impact of failing to follow up on cancer warning signs could literally be of life-or-death proportions. Clearly, consequential consumer decisions such as those regarding health care, housing, insurance, or security involve a substantial proportion of the economy and are likely to occupy a significant proportion of consumers' overall decision efforts. Consequential decision domains can generate negative emotion or stress, thereby causing substantial deviations from normative analyses or even from the descriptive findings associated with more mundane domains (e.g., Luce et al. 1997, 2001). However, despite calls to the contrary (e.g., Alba 2000, Andreasen 1993, Bazerman 2001, Richins 2001), marketing scientists modeling decision making under uncertainty frequently focus on decisions with more limited consequences (e.g., Erdem and Keane 1996, Inman et al. 1997, Walsh 1995).

We focus on a common class of consequential consumer decisions—the decision to obtain information from screening tests. While there has been a great deal of attention in marketing as to how consumers search for information about durables (see Ratchford et al. 1993 for a review), the consumer search for

0732-2399/03/2203/0393
1526-548X electronic ISSN

information that results from engaging in screening tests has been underexamined. However, consumer-initiated testing opportunities are proliferating. For example, in the medical domain people are encouraged to get regular cancer-screening tests, cholesterol tests, bone density tests, vision tests, etc.; and in other domains, people are encouraged to consider home radon tests, lead testing, automotive emission tests, etc. Within the testing context, we examine the effects of "false-alarm results"—where a screening test indicates a positive result that requires further testing but ultimately no evidence of the malady is found—because these situations are quite common. For example, in breast cancer testing, the context of interest in our experiments, the proportion of mammograms requiring some type of follow-up is estimated to be as high as 20% (Lerman et al. 1991b, Lerman and Rimer 1993) with only a small (2%–6%) percentage of these positive results actually resulting in a breast cancer diagnosis. Similarly, Elmore et al. (1998) estimate that over 10 mammograms, the cumulative risk of a false alarm is 49.1%, and the cumulative risk of an associated surgical biopsy is 18.6%. False alarms are common because medical screening tests are often deliberately calibrated to err on the side of false-positive (Type-2) errors rather than the medically more costly false-negative (Type-1) errors. In mammography, false alarms are recognized as "... the major area of concern as far as psychological costs are concerned, although there is insufficient evidence on which to assess the magnitude of the effect" (Wardle and Pope 1992, p. 617).

We conduct our experiments on women who are waiting, in their hospital gowns, to get mammograms. This setting both is realistic and provides the appropriate sampling population. In our Study 1, we find that higher consequences are associated with more disutility for testing, but only following a false-positive test result (not following a normal result). This implies that in high-consequence decision environments such as mammography, false-positive results might ultimately decrease future adherence with testing. In Study 2, we not only document these declines in planned adherence following a false-positive, but we also show that information that facilitates coping can mitigate them. Finally, in Study 3 we find that measured false-positive history is associated with differential reactions to both stress about breast cancer and coping information.

These results have important policy implications. In recent years, mammography has received much media attention (e.g., "Study Sets Off Debate Over Mammogram's Value," *New York Times*, December 9, 2001; "Spotting Breast Cancer: Doctors Are the Weakest Link" and "Mammogram Team Learns from Its Errors" (two-part series), June 27/June 28, 2002; *Newsweek*, "Detection Dilemma," February 4, 2002). The attention has focused on the high error rates of the screening tool, as well as on the efficacy of early detection as life-saving mechanisms. Related media attention has focused on the uncertainty concerning the potential side effects and effectiveness of new treatments and how they might affect the incidence of breast cancer ("Study Is Halted Over Rise Seen in Cancer Risk," *New York Times*, July 9, 2002; "Hormone Replacement Study A Shock to the Medical System," July 10, 2002). All this media attention is likely to cause confusion and anxiety among women, which may deter future adherence to medical guidelines. Even if these women had gotten mammograms in the past, they may be reluctant to get tested regularly or may delay their decision to get tested again. Our results indicate that even without this heightened media awareness, the *personal* testing experience itself, and false-positive results in particular, could in and of themselves significantly influence future decisions about whether to get tested regularly. Because preventive screening is most successful if women get mammograms annually or biannually as recommended, understanding and managing this testing experience is obviously important.

Background Literature

Most prior research addressing test adherence as a function of previous false-alarm mammograms has used survey methodology (Lerman and Rimer 1993), and hence it has been difficult to assess causality (Hughes et al. 1986). Perhaps because of this lack of experimental control, the relevant findings are inconsistent. For example, Lerman et al. (1991a) found that average adherence with later mammograms was

nonsignificantly higher one year after a false-positive (74% versus 68%; $n = 189$; see also Gram and Slenker 1992). One small-sample study ($n = 30$; Pisano et al. 1998) associated a false-positive result with increased testing intentions, although there could be alternative explanations for this increase (e.g., age).

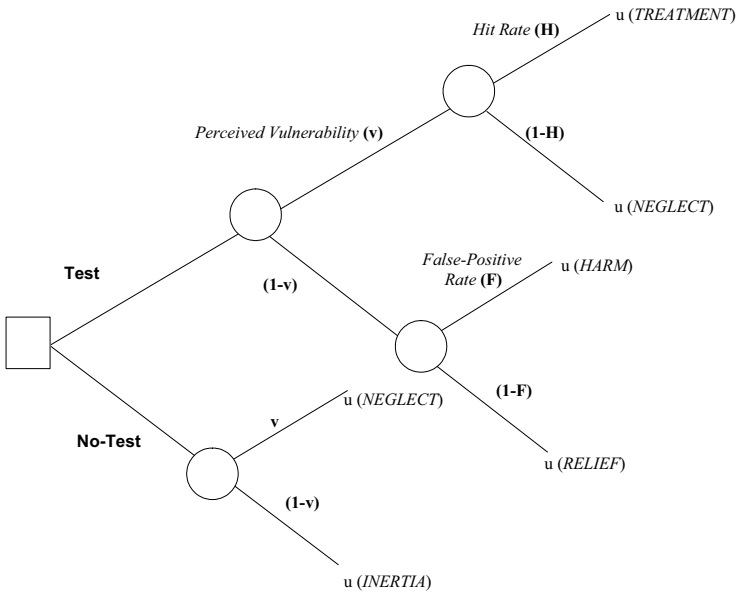
On the other hand, surveys also associate false-positive mammography results with elevated psychological distress, potentially decreasing adherence. For example, Lerman and Rimer (1993) reported that 47% of women reporting notification of "nonnormal" results (but not necessarily breast cancer) experienced mammography-related anxiety three months following screening. This kind of psychological distress is associated with a reduction in repeat mammography screening (Kash et al. 1992; Lerman et al. 1990, 1993, 1994). For instance, a telephone survey of women ($n = 140$, aged 35–79) with a family history of breast cancer found that intrusive thoughts about the disease were significantly negatively correlated with adherence (Lerman et al. 1993).

Value of Information Decision Framework

The normative value of information framework (e.g., Baron and Hershey 1988, Lehmann 1989, Meyer and Johnson 1995) provides a reasonable "as if" model of the process a consumer might use to decide whether to obtain information from screening tests. We adapt this framework to include relevant aspects suggested by the health belief model (Rosenstock 1974, Rosenstock and Kirscht 1977) and social learning theory (Bandura 1985) that have been applied to consumer decisions to engage in health-related behavior (Burns 1992, Dube 1996, Jayanti 1998, Moorman and Matulich 1993, Oliver and Berger 1979) and to mammography adherence (Rimer et al. 1991). Based on this framework, we suggest that three subjective probabilities can affect patients' decisions whether or not to get retested: (i) patient vulnerability, specifically, the perceived likelihood that patients have the disease, (**v**); (ii) the hit rate, that the screening test will detect the disease if it is present, (**h**); and (iii) the false-positive rate, that the screening test will indicate that the disease is present when it is not, (**f**).

There are two main courses of action in our model, getting retested or not (see Figure 1). Following normative decision theory, we postulate that psychologically distinct utilities are associated with different possible uncertainty/action combinations, and we believe that decision makers will forecast these utilities as input to the testing decision. In considering

Figure 1



the utility of testing, there are four outcomes that depend upon whether or not the disease is present and whether or not the test result is accurate. Each of these utilities is a function of both costs and benefits. From the patient's perspective (assuming most monetary costs are covered by insurance), there are two main aspects to each utility—medical and psychological. Here, we focus on the patient's perspective of these psychological costs and benefits, an understudied aspect of testing policy (e.g., Wardle and Pope 1992).

Although some costs are constant across testing outcomes, other costs and benefits differ by decision tree branch, as follows. If the test accurately determines the disease is present, and the patient treats it, the utility is a function of the psychological costs of diagnosis mitigated by the psychological and medical benefits of earlier treatment (U(treatment)). If the test inaccurately determines the disease is not present when it is, then the patient will have an immediate psychological benefit of relief, but long-term psychological and medical costs of neglecting treatment, (U(neglect)). If the test accurately indicates the disease is not present, there is the psychological benefit of relief (U(relief)). On the other hand, if the test inaccurately indicates the disease is present when it is not, there is immediate psychological cost of a "temporary diagnosis" tempered by the later relief when the positive result is determined to be false. This psychological "roller coaster" is likely to be emotionally stressful and is in essence the harm of a false-positive result (U(harm)).[1] Considering the utility of not retaking the test, there are two possible outcomes: Either the patient has the disease and by not testing for it she is not getting treatment (U(omission)), or the patient does not have the disease and is not incurring the costs of testing (U(inertia)). In either case, the main psychological attitude seems to be one of avoidance, and thus psychological costs and benefits of the testing (in)action itself seem unlikely to be salient.

While we do not postulate that consumers explicitly calculate the value of testing information, we believe that the framework is a good starting point for articulating constructs that might be affected by a false-alarm experience. In this research we do not consider accurate positive results, so the hit rate (**h**) and U(treatment) constructs are not relevant. Similarly, the simple utility of an accurate negative result (U(relief)) and the type of errors (Type-1 errors) that are explicitly minimized by policies to set test sensitivities in favor of false-positives (U(neglect)) are less central. There is previous research (Luce and Kahn 1999) to indicate that vulnerability (**v**) might be increased by a false-positive test result in low-consequence testing environments. However, previous research in mammography indicates that perceived vulnerability to breast cancer is not easily assessed by patients (e.g., multiple measures of vulnerability have been found to be virtually uncorrelated with each other) and, further, may be inappropriately high across our population (Schwartz et al. 1999). Consequently, we did not expect (nor did we find) reliable vulnerability ratings. We therefore manipulated vulnerability (in Study 2) to test this aspect of the model. In investigating the effects that false-positive results may have on future testing within this framework, we therefore focus on two aspects of the model: (1) **f**, the false-positive rate of the test and (2) utility of harm, U(harm).

False-Positive Rate of the Test

With regard to **f**, the false-positive rate of the test, we believe, based on past research (Luce and Kahn 1999), that a false-positive result might serve as a salient, vivid reminder of the limitations associated with a screening test result (Ofir and Lynch 1984, Koehler 1996). Thus, a single false-positive result (as opposed to normal results) can reduce the credibility of a link between a positive testing result and the malady and will result in participants believing that the relevant test has a higher false-positive rate (**f**).

U(Harm) as Function of Consequences of the Event

U(harm) is the disutility that a patient associates with the experience of being told he/she has the disease and then finding out later that he/she does not. This "up-and-down" emotional roller coaster associated with unexpected positive results is likely stressful,

[1] There could also be medical harm if there are risks associated with follow-up testing, but we do not focus on this here.

particularly for high-consequence testing situations (e.g., Wardle and Pope 1992, Sutton 1998). Furthermore, it seems unlikely that a mere guessing of the potential harm associated with false-positive results will have the same impact as going through or even simulating the false-positive experience without the foreknowledge that everything will eventually turn out okay. During the time patients are imagining they may have the disease, they are likely to spontaneously generate explanations of the positive test result that remain salient and persuasive even after the impetus for these explanations is discredited. This "persistence of belief" effect (Ross et al. 1977) can occur even when participants know all along that the relevant consequences are hypothetical (Ross et al. 1986) and appears to be specifically tied to the mental experience of considering the hypothetical consequences. Therefore, we believe that patients will update their disutility of harm as a result of going through the (even hypothetical) process of a false-positive experience. The impact associated with imagining having the malady and the relief in finding out subsequently that one does not have it is likely to be sensitive to the magnitude of test consequences, as high- (versus low-) consequence environments should be associated with more extreme emotional reactions.

When there is a normal test result, there is no variability in emotional response and no spontaneously generated explanations for what is occurring, as the normal test result is the expected test result. Therefore, there should be no differences in the disutility of harm as a result of the consequences of the testing situation.

Thus, we hypothesize as follows.

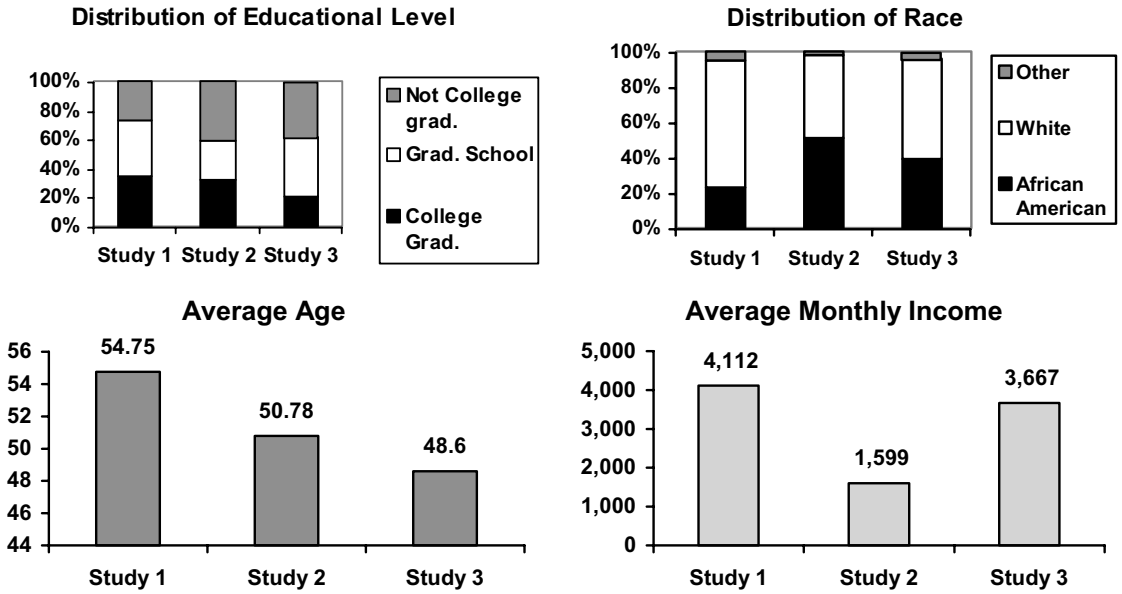
Hypothesis 1 (H1). *For false-positive test results* (*but not for normal test results*), *the higher the consequences of the decision*, *the higher consumers' disutilities of harm*.

In Study 1, we manipulate the consequences of the testing decision to examine the effects of false-positive results on participants' *utilities of harm* and their perception of the false-positive rate of the test, $\mathbf{f}$.

Study 1: Decision Consequences as a Function of False-Positive Results

All three of our studies were conducted in a University Hospital mammography waiting room, sampling women dressed in hospital gowns. Figure 1 provides descriptive statistics for the three samples. Participants across the studies were paid $10 for their participation and randomly assigned to between-subjects

Figure 2 Descriptive Statistics for the Three Studies



conditions. None of the women we study had been diagnosed with breast cancer, and most were waiting for routine, screening mammograms. Following each study, subjects were debriefed and told to talk to their doctors if they had any questions about their own care. Materials in all studies were either factually true or explicitly hypothetical and research assistants ensured that participants understood this. Studies 1 and 2 were conducted via paper questionnaires, while Study 3 used a computer program.

Study 1 was a 2×2, between-subjects design manipulating test results (normal/false alarm) and context (mammography testing for cancer/skin density testing for wrinkles). Sixty-four subjects completed all measures and were retained for analysis. For the high-consequence mammography context, women simulated the process of receiving their mammography results. We had assistants hand women results in envelopes. This approach was quite realistic, especially because of the personal interaction. In fact, the research assistants were told to clearly remind patients that this was a research study and did not affect patients' actual mammography results.

For the low-consequence decision context, women considered the results of a skin density test. Information for the skin density test was taken from an actual consumer-products manufacturer's Web site. Similar to mammography (where women's breasts are compressed and studied to see if there is evidence of cancer), the skin density test compresses a women's facial skin to determine the level of skin density loss that is linked with aging. Because the testing situations were so parallel, it was relatively easy to match the background and testing information across the two contexts. We expected the ambient levels of stress to be comparable across the two conditions, as all our participants were recruited during actual mammography testing.

For the results manipulation, patients imagined that they had just undergone the test and were about to receive their results. The first group was told to imagine an initial positive test result negated by a second more accurate test (*false-alarm condition*). The second group was told that an initial test and more accurate follow-up test both indicated normal results (*normal condition*). Mentioning the second test across both conditions was designed to provide a conservative operationalization of our manipulation, in that we held constant the mention of a more accurate test. The second test was unspecified to minimize specific attributions regarding that test. Participants were asked to write out the reactions they would have following their first test result. We did this to encourage them to think through the hypothetical testing situation, and particularly to encourage the type of elaboration that would accompany a real false-alarm situation.

We believe that our experimental methods approximate the psychological experience of a real-world false-positive. For instance, a real-world "cancer scare" often involves an asymptomatic patient being informed by a doctor about a problematic test result, and spending time thinking about the implications of that test result while undergoing further more accurate testing to find the initial result was an error. Similarly, we take participants through the involving process of reacting to a positive and then a negative test result. Thus, the main difference in our manipulation of a hypothetical false-alarm mammography result and what women may actually experience is some time compression.

After an introduction to the context, all subjects completed a stress measure as a check of the consequences manipulation (*background stress*: "...how stressful is it for you to think about getting breast cancer/wrinkles?"). Then, participants considered the test results. Next, participants were asked dependent-measure questions including assessments of harm (U(harm)), beliefs about the false-positive rate (**f**), vulnerability to the relevant malady (v), and stress felt about the test result (*test stress*).

Results

Vulnerability was assessed with measures addressing perceived likelihood of getting the relevant malady in the following 10 years and over the participant's lifetime. The mean of an averaged vulnerability measure was 2.98 on a five-point scale and was not influenced by our manipulations ($Fs < 1$).[2] Background

[2] It is possible that one way to interpret these vulnerability scores is that the women really do not know how to calibrate probability

stress regarding the relevant context was higher for breast cancer ($M = 3.87$) than for the skin/wrinkles ($M = 2.70$) as expected ($F(1, 62) = 16.98$, $p < 0.0001$, $\omega^2 = 0.19$), and thus our manipulation of consequences was successful.

Across both contexts, participants in the false-positive result condition believed the false-positive rate of the test (**f**) was higher ($M = 3.64$) than participants in the control result condition did ($M = 3.53$, $F(1, 62) = 4.15$, $p < 0.05$, $\omega^2 = 0.04$), replicating prior research.

To measure the utility of harm we asked all respondents: "How distressed would you be if you were tested for low-density skin (*breast cancer*) on one day and that test indicated you had low-density skin (*breast cancer*), but you found out soon after through a second, more accurate test that you did not have the problem?" and "How terrible would it be if you were tested for low-density skin (*breast cancer*) on one day and that test indicated you had low-density skin (*breast cancer*), but you found out soon after through a second, more accurate test that you did not have the problem?" ($r = 0.76$).

As predicted in Hypothesis 1 (H1), we found a result × context interaction for utility of harm ($F(1, 54) = 5.45$, $p < 0.02$, $\omega^2 = 0.07$), using background stress as a covariate in the analysis. For a false-positive result, the high-consequence context caused false alarms to be evaluated significantly more negatively in terms of harm ($M = 3.51$) than was the case for low consequences ($M = 2.70$, $p = 0.02$). However, this relationship did not exist (and even directionally reverses) for normal results, where the harm is lower ($M = 2.62$) in the high-consequence context than in the low-consequence context ($M = 3.15$, $p = ns$). Thus, as expected (H1), the test result moderates the impact of the decision context on U(harm).

and so they are thinking of it as 0 (no possibility), 1 (definitely have breast cancer), or 50–50 that they will get it. Our vulnerability measures are basically at the midpoint, consistent with this 50–50 type of thinking. In addition, note that we measured the additional five utilities specified in our decision tree, but none of these factors showed effects of the manipulations and so, for brevity, they are not discussed.

Test Stress as a Mediator

We predicted that within false-positive results it is the "emotional roller coaster" and lingering stressful thoughts that are increasing the utility of harm. We would expect that the consequences of the decision context influence the test stress (measured after receiving the results) and that this test stress influences the disutility of harm. Furthermore, we would expect that test stress would mediate the testing context effect. Within normal results these thought processes are not occurring, as the test results are as expected, so we would not expect test stress to influence U(harm). As predicted, for normal test results, neither consequences nor test stress significantly affect U(harm), although consequences do significantly affect the test stress patients feel after being given the result, ($F(1, 31) = 15.26$, $p = 0.0005$, $\omega^2 = 0.26$). However, when there is a false-positive result, the consequences of the decision context affect the test stress patients feel ($F(1, 29) = 12.17$, $p = 0.002$, $\omega^2 = 0.20$), and this test stress affects the patient's U(harm), ($F(1, 28) = 4.28$, $p = 0.05$, $\omega^2 = 0.10$). Furthermore, the effect of consequences of the decision context on the patient's U(harm) ($F(1, 29) = 5.65$, $p = 0.02$, $\omega^2 = 0.14$) is mediated by test stress, as the F-statistic is significantly reduced when test stress is introduced into the equation ($F(1, 28) = 2.21$, $p = 0.15$, $\omega^2 = 0.03$).

Discussion

Study 1 showed that false-positive results can have two negative consequences. First, a false-positive result is associated with increased disutility of harm given a high- (versus low-) consequence context. Second, a single false-positive result can increase the perceived false-alarm rate of the test, regardless of the context. These effects occur even though all participants are told at the end of the study that they have received a normal test result. Recalculating the value of testing on the decision tree in Figure 1 with an increased **f** and a higher *disutility of harm* implies that false-positive results should decrease intentions for future testing in high-consequence decisions. This implication is specifically tested in Study 2, using a more direct behavioral dependent variable, planned future adherence with testing. For tighter experimental control, we test our hypotheses within one

context, mammography, a high-consequence environment where we have shown that false-positive results can increase U(harm). In addition, we manipulate the perceived consequences of the testing situation by providing coping information to some patients after they receive their test results. We use this manipulation because it has potential managerial/policy implications in that it is a marketing/communications tool that can be implemented in actual medical settings. We predict that within the false-positive conditions, the coping information will lower the consequences of the testing context, mitigating the negative effects of false-positive results on planned adherence.

Study 2: Effect of False-Positive Results on Future Test Adherence

Based on the results of Study 1, we believe that false-positives might be associated with dysfunctional effects leading to decreased mammography adherence. There are two boundary conditions that should mitigate this negative effect. The first is if the false-positive result, while not currently indicating the presence of the disease, did indicate that a patient was at increased risk, thus increasing a patient's perceived vulnerability (**v**). For example, in colonoscopy testing the discovery of a benign polyp may indicate an increased risk of cancer. Similarly, some false-positive mammography results, while not indicating the current presence of breast cancer, may indicate that the patient is at increased risk in the future. Increases in **v** should increase planned adherence, and thus mitigate decreases in adherence due to the false-positive result. The second boundary condition, based on the results of Study 1, would be if something (e.g., coping information) was provided to lower the perceived consequences of the testing situation. Thus, we hypothesize as follows:

Hypothesis 2 (H2). *In high-consequence testing environments, in the absence of coping information, "false-alarm" results will decrease subsequent intentions to get retested* (*or increase delay in getting retested*) *as compared to normal results or false-positive results that increase risk.*

We also expect, following previous research (Luce and Kahn 1999) that all types of false-positive results will generate increased stress and decreased test confidence.

One way to limit the decreases in subsequent intentions might be the provision of information lowering the perceived consequences of the testing situation by helping patients cope with the stress that is generated through the false-positive process. In the emotion literature, Lazarus (e.g., 1991) argues that if a coping strategy is facilitated, it can mitigate the effective stakes of a high-consequence environment, making it more like a low-consequence environment. Consistent with Lazarus's model, we expect that providing women with information to help them cope will lessen the stress associated with mammography, and we use test-related stress as a manipulation check. In contrast to previous research involving personalized information (e.g., Schwartz et al. 1999, Audrain et al. 1999, Lerman and Rimer 1993), we are interested in information that can be provided easily in a medical facility and therefore is not individualized. Thus, our information interventions are designed to mitigate the high-consequence nature of this testing context by providing generalizable and factually true information. We do this through the two pathways to coping identified by Folkman and Lazarus (1988): (1) problem-focused coping where patients are given an action plan and (2) emotion-focused coping involving a reappraisal or reframing of the situation in the absence of underlying change.

Problem-Focused Coping

To the degree an individual feels she can do something to improve a situation, she is likely to engage in active, problem-focused coping efforts and therefore to expect more favorable consequences (Bandura 1982, 1997; Bandura and Schunk 1981; Folkman and Lazarus 1988; Morris and Ingham 1988). Information that generates feelings of personal control appears to be particularly important when conditions are ambiguous (Folkman and Moskowitz 2000, Carver et al. 2000). For instance, Rippetoe and Rogers (1987) find that telling patients ways to increase the effectiveness of breast self-examinations (BSEs) results in a more rational, problem-solving approach to breast cancer prevention and greater intentions to perform BSE. Similarly, increasing problem-solving coping skills appears to increase the tendency to engage

in BSE among women with high levels of stress (Audrain et al. 1999).

The breast cancer detection method most under direct control of patients is monthly BSEs. We believe that providing the patient who has a "false-alarm" result with BSE information will lower stress associated with the false-positive process and increase adherence intentions by encouraging active, problem-focused coping. We expect patients to generalize from a message that they are in control of one aspect of cancer screening (BSEs) to another, related aspect (mammography testing). Therefore, women should feel empowered to cope with the situation and not feel as overwhelmed regarding potential consequences of the test. In H2 we predicted increases in delay following false-alarm test results; we expect this delay to be mitigated by BSE information.

Hypothesis 3 (H3). *For false-alarm results*, (*but not for normal or false-alarm results with increased risk*), *BSE information as compared to control* (*no coping*) *information will*:

(a) *be associated with lower stress*,

(b) *be associated with higher planned adherence* (*or lower delay*).

Emotion-Focused Coping

The other type of information we consider potentially regulates stressful reactions to a false-positive more directly. If patients are made aware that mammography is only the first step in the screening process, and a positive result does not necessarily mean that breast cancer will be detected (*Mammography is not definitive* (MND)), they may experience less stress with the false-alarm process and higher adherence intentions than if they received no such information. Previous research (Lerman et al. 1992) has found that providing women who had abnormal mammograms in the past (but were not diagnosed with breast cancer) with information describing the meaning of the abnormal mammogram increased adherence of mammography (67% versus 54%). Thus, there is some evidence that this sort of coping information mitigates the dysfunctional effects of a false-positive. On the other hand, emphasizing the inherent fallibility of positive mammogram results may lower feelings of confidence in the test, introducing delay in adherence. Given these conflicting possibilities, we cannot predict a priori whether learning that mammography is not definitive for detecting breast cancer will increase or decrease subsequent adherence. It will depend upon whether the major effect is to reduce the stress and anxiety that is associated with the *false-alarm* result, or whether the major effect is to reduce confidence in the test itself (i.e., increase $\mathbf{f}$). As before, however, providing the information is less likely to affect control subjects receiving an expected *normal* result, or *false-alarm/increased risk* subjects.

Hypothesis 4 (H4). *For false-alarm results*, (*but not within normal or false-alarm results with increased risk*), *Mammography Is Not Definitive* (*MND*) *information as compared to control* (*no coping*) *information will*:

(a) *lead to increased perceived false-positive rates*,

(b) *be associated with lower stress*,

(c) *affect planned adherence* (*delay*).

Procedure and Manipulations

Ninety-seven women participated in this study. In the analysis of adherence intentions, 10 subjects were deleted because of failure to complete survey items. In the other analyses, six subjects were deleted because of such failure.

This experiment was a 3 (result: false alarm; false alarm with increased risk, normal) $\times$ 3 (information: BSE, MND, control) between-subjects design. All subjects were first told some background facts about breast cancer, were exposed to the manipulations, and then asked to respond to dependent variables.

False-Positive Manipulation. As in Study 1, all patients imagined that they were about to receive their mammography results. One group imagined an initial positive test result negated by a more accurate test (*false-alarm condition*) and another group imagined that both tests indicated normal results (*normal condition*). Here, we added a third condition in which patients were given an initial positive result negated by a more accurate test that indicated they did not have breast cancer at this time, but that they did have a change in breast tissue. This change in tissue indicated an increased risk of developing breast cancer in the future (*false-alarm/increased risk* condition). We use

this condition to test for the role of vulnerability (v) in our model, as measured ratings of perceived vulnerability are notoriously noisy in patient decision-making contexts (Roter and Hall 1992, Spiro and Heidrich 1983).

Information Manipulation. Patients were exposed to one of three information conditions between their two test results; thus, the information was salient during the patient's process of coping with their initial test result. All information conditions had approximately the same number of words, and all were accompanied by mammogram-related graphics. In the control cell, subjects were given information repeated from the study introduction (i.e., describing mammograms). In the breast self-exam (BSE) condition, subjects were instead provided with an explanation of the efficacy of breast self-exams, emphasizing the patient's role in the screening process and providing an outlet for a woman to exercise some control in this process. In the mammogram not definitive (MND) condition, subjects were told that a positive mammography result does not necessarily mean that the patient has breast cancer, highlighting the fact that mammography is only a first step in the screening process.

Dependent Measures

Our primary dependent variable is subjects' planned adherence measured through five questions (alpha = 0.80, see Appendix) that focus on measuring intended delay. We also measured subjects' stress levels after receiving their test results using four questions (alpha = 0.66). The last dependent variable was confidence in the test, operating through the perceived false-positive rate (**f**), which we measured by asking "How likely do you think it is that a woman with a positive mammogram test result has breast cancer? I believe that a woman who has a positive mammogram test result definitely (1 = does not have breast cancer, 5 = has breast cancer)." We also assessed patient's perceived vulnerability (**v**) by asking each subject "If you really went through this experience with mammogram test results, how likely would you think it is that you would get breast cancer: (1 = I will not get breast cancer during the next 10 years, 5 = I will get breast cancer during the next 10 years).

Results

The mean vulnerability rating was 2.70, with no significant effects of our manipulations as in Study 1. To test our hypotheses, we regressed our adherence (delay), test stress, and test confidence measures on our two manipulated factors: the mammogram result (*Result*) and the information condition (*Info*). We included covariates that controlled for family history and overall vulnerability to breast cancer. There were no significant interactions involving the covariates.

Our manipulation check indicated that coping information lowered test stress across all three test result conditions, ($F(2, 81) = 8.81$, $p = 0.0003$, $\omega^2 = 0.12$). Test stress in the control information conditions was significantly higher ($M = 3.37$) than it was in the BSE conditions ($M = 2.69$, $p = 0.0008$) and in the MND conditions ($M = 2.49$, $p = 0.0002$). This indicates that coping information lowered the perceived consequences of the testing environment.

For all three dependent measures, we found two-way interactions of result $*$ info, (for adherence, $F(4, 75) = 5.07, p = 0.001, \omega^2 = 0.13$, for stress, $F(4, 81) = 3.05, p = 0.02, \omega^2 = 0.06$, and for confidence, $F(4, 81) = 4.28, p = 0.003, \omega^2 = 0.11$). Our hypotheses identify specific planned comparisons within the control information conditions and within the false-positive test result conditions.

Results Within the Control Information Conditions

Replicating past research, we show that in the control information conditions false-alarm results generate stress and reduce confidence. As expected, we found that the stress associated with the false-alarm condition ($M = 3.65$) and with the false-alarm/increased risk condition ($M = 3.83$) were significantly higher than the stress associated with the control condition ($M = 2.62$) ($p = 0.01$ and $p = 0.004$, respectively). Also as expected within the no-information condition, we found confidence in the test was significantly lower for the false-alarm condition ($M = 3.00$) and for the false-alarm/increased risk condition ($M = 2.57$) than for the control condition ($M = 4.33$) ($p = 0.001$ and $p = 0.0001$, respectively). Therefore, false-alarm test results increase patients' subjective false-positive rates (**f**).

We found support for H2, that adherence in the false-alarm condition ($M = 3.90$) was lower than in the normal test result condition ($M = 4.55$) or in the false-alarm/increased risk condition ($M = 4.51$, $p = 0.07$ and $p = 0.05$, respectively). While patients in the false-alarm/increased risk condition show increased test stress and decreased confidence, their planned adherence rates did not differ from the control ($p = 0.91$), presumably because they were also told they had increased vulnerability. This result provides support for the model in Figure 1 with regard to perceived vulnerability.

We expect this decrease in adherence in the false-alarm test result conditions to be mitigated by BSE information (H3) and potentially influenced by MND information (nondirectional H4). While our experimental design crossed results and information, H3 and H4 address only the effects of information within the *false-alarm* result condition.

Results Within the False-Alarm Test Result Conditions

Across the group of subjects receiving a *false-alarm* result, we found that BSE information significantly increased adherence ($M = 4.78$) over the control information ($M = 3.90$, $p = 0.002$) and that MND information similarly significantly increased adherence ($M = 4.75$) over control information ($p = 0.006$). Thus, H3(b) and H4(c) are supported, suggesting that the BSE and MND information mitigates the increased delay that is associated with a false-positive result.

In addition, coping information in the *false-alarm* condition is associated with significant decreases in test stress in the BSE condition ($M = 2.89$) and in the MND condition ($M = 2.76$) as compared to the control condition ($M = 3.65$, $p = 0.03$ and $p = 0.03$, respectively). There were also marginal increases in test confidence for the BSE ($M = 3.64$) and MND ($M = 3.78$) information conditions relative to the control condition ($M = 3.00$, $p = 0.09$ and $p = 0.06$, respectively.) Thus, H3(a) and H4(b) (involving coping information mitigating test stress) are supported, while H4(a) (involving MND information decreasing confidence) is not. That the confidence of the test is not increased, but the test stress is lowered suggests that the MND information manipulation worked as a coping mechanism rather than as a mechanism to lower confidence in the test.

Information Effects in Other Result Conditions

We did not predict information effects on adherence for the normal result and false-alarm/increased risk result conditions, because there were no predicted decrements in adherence to be mitigated. As expected following a normal test result, the BSE information condition ($M = 4.14$) and the MND information condition ($M = 4.49$) were not significantly different from the control information condition ($M = 4.55$) ($p = 0.17$ and $p = 0.87$, respectively). Similarly, following a false-alarm/increased risk result, the BSE information condition ($M = 4.80$) and the MND information condition ($M = 3.99$) were not significantly different from the control information condition ($M = 4.51$) ($p = 0.33$, and $p = 0.15$, respectively).

Stress as a Mediator for False-Positive Results

As in Study 1, we would predict that the decreased adherence for false-positive results observed in the control information condition was due to the "emotional roller coaster" associated with simulating the positive, then negative, results. We hypothesized this decreased adherence would be mitigated when information lowered the perceived consequences of the situation. Thus, as in Study 1, one might expect that the information conditions decreased adherence through stress reduction, or that stress mediated the information effect. Within the false-positive test result condition, the information conditions affect the test stress patients feel about the result ($F(2, 25) = 2.66$, $p = 0.09$, $\omega^2 = 0.10$), but this test stress does not affect the patients' adherence ($F(1, 24) = 0.10$, $p = 0.75$) and clearly cannot mediate the F-statistic for the relationship between information and adherence (which is $F(2, 25) = 5.71$, $p = 0.01$, $\omega^2 = 0.24$ without stress and $F(2, 24) = 5.94$, $p = 0.01$, $\omega^2 = 0.25$ with stress in the equation).

Discussion

This experiment indicates that patients receiving a false-alarm result experienced more test stress, were less likely to believe that a positive mammography result indicated cancer and were more likely to delay

mammography than patients receiving normal results or patients who received a false-positive result but were told that they were at increased risk for breast cancer. Information, either about performing BSE or indicating that the mammogram is a screening test that merely suggests when further testing is required, mitigated the delay effects in the false-alarm conditions. Patients in the normal or false-alarm/increased risk results conditions did not respond to information.

In combination, Studies 1 and 2 indicate that false-positive results can decrease planned future adherence in high-consequence contexts. Study 1 uses a manipulation to directly vary the severity of the consequences of the test. This study shows that for false-positive results the consequences of the decision context affect the test stress experienced, and this test stress affects the perceived disutility of the harm of the test, a process that does not occur for normal test results. Study 2 shows that within a high-consequence decision context, false-positive results increase test stress, decrease confidence in the test, and decrease planned adherence, as compared to the other test result conditions. Finally, Study 2 shows that information interventions designed to facilitate coping reverse the detrimental effects of false-positives on planned adherence.

The process as to how information interventions mitigate adherence decreases is not fully explained by our results. We hypothesized that the information conditions would lessen test stress and thus lessen the perceived consequences associated with the test environment in general and the false-positive experience in particular. However, although our information manipulations did both decrease stress and increase patients' planned adherence after a false-alarm test result, we did not find evidence of test stress mediating our effects. This may be because consequences were operationalized differently in Study 1, as opposed to those of Study 2. While in Study 1 we directly changed the consequences of the situation, in Study 2 by providing information we are not really mitigating the threatening consequences of the breast cancer context but rather are providing a coping mechanism. While coping certainly affects stress, there is not a one-to-one mapping between coping and experienced stress, so we would have less reason to expect that stress would mediate in this situation. This is consistent with the Lazarus framework cited earlier in that appraisals of "stakes" and of "coping prospects" are considered separable mental processes. Similarly, the (U(harm)) dependent variable in Study 1 seems likely to have a more direct relationship with stress than with adherence, the dependent variable in Study 2, as adherence may be affected by other factors such as individual differences and medical history. Although we believe that the decreases in stress are playing a part in increasing the adherence in Study 2, it may also be that, for example, for some patients information that "tells them what to do" causes adherence in spite of stress remaining high. Thus, exactly how information affects subsequent adherence is left for future study.

One of the main conclusions of both Studies 1 and 2 is that false-positive results are an important moderator of the relationship between test consequences and women's decisions to get mammograms. We find that false-alarm results increase sensitivity to test consequences (Study 1) and to coping information (Study 2). Thus, false alarms appear to color reactions to the testing environment, creating potentially dysfunctional effects within threatening situations if they are not mitigated by coping mechanisms. Because screening tests are often performed at regular intervals, this suggests that prior false-alarm results may make patients more sensitive to the stress associated with later false-positives, in turn generating decreased adherence. That is, lingering stress from one false-positive might make a patient more susceptible to the negative effects (e.g., the U(harm) effect in Study 1) associated with a later false-positive. Given that we have ethical constraints on our ability to manipulate stress and operational constraints on participants' abilities to imagine multiple false-positive events in a compressed time period, in Study 3 we measure stress and examine how the presence of an *actual* false-positive medical history may affect the retesting decision. Specifically, in Study 3 we simulate only the false-alarm test results conditions for all participants, and we measure previous false-positive history. In addition, because we found that the perceived consequences (operationalized by measured

stress) and coping information significantly affected the reactions to false-positive results, we also measure each patient's ambient stress about breast cancer and manipulate coping information. While this study was run under significant operational constraints,[3] we will briefly review the major results, as we believe they are suggestive of an interesting process.

Study 3: Influence of Actual False-Positive History on Testing

Participants ($n = 75$) were assigned to three information conditions roughly analogous to the control, BSE, and MND conditions in Study 2 with the important caveat that the information in the current study was more specific, and as later revealed by posttest, generally less reassuring. After providing background information we asked patients to forecast stress they would feel regarding "thinking about getting breast cancer" (*background stress*). Then, *all* subjects were asked to imagine test results that were similar to the *false-alarm* conditions in previous studies. We then classified women based on their answers to: "Have you ever had a mammogram result that suggested further testing was necessary, only to find out later there was no problem?" which appeared at the end of the survey. Thus, we are evaluating the effect of a prior false-positive history on the process of reacting to our simulated false-positive event.

Given that we were restricted to a single computer in the waiting room, we used only single-item measures to minimize study time. Our key dependent variable was planned adherence; i.e., "Think about the next time you are due for a mammogram and imagine that you can get a confidential, low-cost mammogram in a nearby location. If so, would you get your next mammogram as soon as you are due for it?" (Scale anchors were: "I would get my next mammogram as soon as I was due for it without delay" and "I would not get my next mammogram as soon as I was due.") The adherence and stress measures were calculated on a 0–100 scale, with participants seeing only a sliding scale with verbal endpoints.[4] We will report statistical tests on these continuous scales below; however, because both demand and the specific scales apparently biased subjects toward indicating high planned compliance, we believe it might be more telling to summarize our findings in terms of a 0, 1 measure, where 1 indicates planned future adherence with no delay.

Results and Discussion

We find that background stress about breast cancer is nonsignificantly higher for women with a false-alarm history ($M = 63$ versus $M = 61$; $F(1, 74) < 1$), indicating that our stress and false-positive variables vary somewhat independently, allowing us to model their interactive effect on delay.

Using only the control information group, we evaluate whether baseline stress (unmitigated by coping information) is indeed more troublesome for women with a prior false-positive. The main effect of false-positive history does not influence adherence ($F < 1$). However, stress does influence adherence, and these the two factors significantly interact ($F(1, 22) = 5.00$, $p < 0.04$, $\omega^2 = 0.06$). The main effect beta weight for background stress is positive (beta $= 0.27$, $p < 0.02$), but that is qualified by an interaction indicating a negative effect of stress for women with false-positive history (beta $= -0.47$, $p < 0.04$). When women are faced with simulated false-positive test results, stress appears to increase delay given prior false-positive history (r(stress, adherence) $= -0.40$), but decreases delay for women with no false-positive history (r(stress, adherence) $= +0.52$). We also perform a median split on stress; for women without a false-positive history, background stress appears to motivate adherence following the simulated false-positive

[3] In this study, we attempted to automate our data collection through the use of a personal computer. Unfortunately, this necessitated that dependent variable measures were briefer than in past studies. In addition, both the specific information manipulations we developed for this study and, more generally, the computer interface, seemed more uncomfortable for subjects than was the case in Study 2. Thus, while we will briefly review Study 3, we believe that this study is limited, particularly in terms of the (one-item) adherence variable and the fact that a later posttest indicated that the information manipulation used in that study was not as reassuring as the manipulation developed for Study 2.

[4] Other questions were asked in this experiment because this described process was part of a larger study, but those questions are irrelevant to our discussion here so that information is not included, for the sake of brevity.

result (low stress = 77 versus high stress = 100), while for women with a false-positive history, stress had dysfunctional effects, lowering planned adherence (97 versus 87). The means are even more striking for the dichotomous delay value; again women without a false-positive history comply more if they report stress (0.11 versus 1.0) while the direction reverses for women with a history (0.75 versus 0.29). Consistent with Study 1's finding that false-positives increase harm within stressful contexts, we find here that false-positive history seems to generate delay for highly stressed decision makers while actually decreasing delay for those under lower stress.

Given that women with a false-positive history were apparently more susceptible to the negative effects of stress, we thought they might also be influenced more positively by coping information. While neither main effect is statistically significant, the false-positive history by information interaction is significant ($F(2, 61) = 3.30,\ p < 0.04,\ \omega^2 = 0.07$). Given a no-false-positive history, women showed similar intentions across the control (scale value = 86, dichotomous value = 0.47), BSE (88, 0.35), and MND (81, 0.38) conditions. However, given false-positive history, adherence was lower for control information (90, 0.45) than for BSE (97, 0.92) or MND (98, 0.70) information.

Overall, we find that (measured) false-positive history causes both more dysfunctional effects of baseline stress and greater advantages for coping information. While we did not find differences in terms of intended adherence (in the absence of information) based on prior history, we did find evidence that the effects of stress and information—in a false-positive condition—do depend on history. That is, while in the *absence* of a prior false-positive history, more-stressed women comply more; in the *presence* of a prior false-positive history, more-stressed women comply less. Consistent with the finding that stress is more problematic for the false-positive history group, coping information is more beneficial in that group.

General Discussion

We investigated how women in the process of getting a mammogram would determine future mammography adherence following a false-alarm test result, a false-alarm result that also indicates increased risk of breast cancer or a normal test result. Within a value-of-information framework, we determined that false-positive results could affect future retesting decisions through two pathways, decreased confidence in the test (increases in the false-positive rate, **f**), and increases in the *disutility of harm, U(harm).* In particular, we hypothesized that a false-positive could lead to increased sensitivity of harm depending on decision consequences, potentially leading to delay in further testing.

Our basic conclusion is that false-alarm results might decrease future adherence, subject to several important boundary conditions. In Study 1, we found that in low-consequence decision contexts, the disutility of harm is not increased by the false-positive experience. In fact, within the low-consequence conditions, the U(harm) was directionally lower for the false-alarm test result ($M = 2.75$) than for the normal test result ($M = 3.15$). Perhaps when the consequences are mild enough, the false-positive experience decreases perceived disutility of harm because the consumer realizes that a positive diagnosis is nothing to fear. Thus, false-positive results seem less likely to result in decreases in future test adherence when consequences are not life threatening. This pattern of results helps reconcile earlier work showing that false-positive results can increase test adherence, apparently by increasing vulnerability, in lower-stakes environments (Luce and Kahn 1999). Our results here suggest that in addition to increasing perceived vulnerability in those studies, the false-positive results did not have negative effects on assessments of the harm utility.

In Study 2, we consider the effects of a false-positive test result within the single, high-consequence domain of mammography and investigate two boundary conditions. First, we find reductions in planned testing following a false-positive test result, but if a false-positive result is linked with increased risk, these reductions do not occur. This last result also is consistent with the previous Luce and Kahn (1999) results; even in high-consequence decision contexts, if perceived vulnerability is increased decreases in adherence do not occur. Second, we find that provision

of coping information lowers test stress and mitigates the adherence decrements following from a false alarm. This form of coping information could be provided in medical settings, so this manipulation has important potential policy or marketing implications.

In Studies 1 and 2 we also attempted to understand the underlying process. In Study 1, we found that test stress mediated the effect that consequences had on the utility of harm following a false-positive result. Stress had no influence on utility of harm following normal test results. In Study 2, our mediation tests were unsuccessful. We did not find evidence that test stress mediated the effects that coping information had on planned adherence, perhaps because the appraisal of stakes and coping prospects are somewhat independent.

Finally, in Study 3 we consider the effect of actual false-positive history and baseline stress on future adherence. Here, we again ask the patient to imagine a simulated test environment, but we provide only the false-positive test result experience. We find that given prior false-positive history, stress decreases adherence, while the relationship is reversed in the absence of false-positive history. Consistent with the more negative effects of stress in the false-positive-history group, we found that coping information only helped that group. Thus, in all three studies we find a strong moderating impact of false-positive results on planned adherence. Furthermore, the analysis of our measured variable in Study 3 indicates that false-positive effects may accumulate over time, with prior false-positive results causing consumers to be most vulnerable to the negative effects of later false-positives. While Study 2 establishes that coping information is, on average, helpful given false-positive results, Study 3 finds that the coping effects of information are stronger for women with prior false-positive histories. There are several important methodological (dependent variable measures) and substantive (the degree to which information manipulations were reassuring as measured in a posttest) differences between these studies. Thus, we believe future research is needed to better integrate the implications of these two studies by attempting to determine when and how background individual difference characteristics influence reactions to false-alarm results and coping interventions. The story that most clearly emerges is that false-positives both cause stress and increase U(harm), and can decrease planned adherence in high-consequence situations. Thus, in contexts where repeated false-positives are likely, policy makers should ensure that patients are given tools to deal with test- and disease-related stress.

Implications

We have identified a value-of-information framework that can easily be extended to other stressful consumer decisions. We have also shown the merit of sampling consumers in a realistic setting, particularly for understanding emotional responses, e.g., reactions to coping information or experienced stress. We believe that our research has important policy implications. First, we have designed information-intervention strategies that could easily be provided in waiting rooms. These types of information can help women cope with the stress that they are experiencing. Our results also suggest that there might be a cumulative effect, such that women who experience several false-positive situations may be particularly vulnerable to decreases in adherence if they cannot deal with disease-related stress. Thus, the (somewhat preliminary) results of Study 3 indicate that such information should be tailored to the stage of testing, in particular to whether a woman has had a prior false-positive. This might have some of the advantages associated with individual tailoring of mammography-related messages (Schwartz et al. 1999, Audrain et al. 1999, Lerman and Rimer 1993), but at relatively low implementation costs. At a minimum, we believe we have established that false-positive test results influence reaction to test factors (particularly regarding the perceived consequences of the test) and should be further investigated as an important moderator of reactions to test results and information.

Our measures of mammography adherence were likely to be positively biased in that we used a sample of women who had made the decision to get tested. Thus, our results likely underestimate the detrimental effects of false-alarm results on future testing. Our findings may be useful to those professionals

charged with setting guidelines for administering and interpreting test results. For many tests, it is possible to control test sensitivity, influencing the ratio of false-positive to false-negative errors. In order to set optimal ratios, the decision maker must estimate the utilities associated with a true-positive, a false-positive, a true-negative, and a false-negative (e.g., Swets 1986). Our methodology may provide some guidance for doing so.

Limitations and Future Research

Our methodology was subject to several inherent limitations. The combination of the consequential implications and our desire to use the appropriate subjects constrained our choice of both independent and dependent variables. Future work might further our understanding of the relevant underlying processes by using different manipulations and measures.

In particular, it would be useful for future research to empirically address how the background factor of false-positive history affects both responses to various testing results and information interventions. Our results in Study 3 suggest that the decreases in adherence observed in Study 2 and the increases in utility of harm observed in Study 1 in the mammography context may have been driven more by women who had false-positive history. As noted in our introduction, exposure to a false-positive mammography result for women over 35 is not that rare; however, it is probably very likely that few of these women in our sample received a false-positive skin density test result. Thus, a possible explanation for our context interaction in Study 1 (although a less plausible one in our opinion) is that more women had false-positive history in the mammography context than in the skin density context, and it is that testing history, rather than the consequences of the testing context, that is driving the difference in the utilities of harm. Although this alternative explanation would not really change the implications of our results so far (i.e., false-positive results can deter future adherence), future research that would clear up this possible alternative explanation would help us understand that exact mechanism that is driving our results.

Another area for future research involves the effect of cumulative false-positive history. Repeated false-positive experiences are not uncommon in mammography, so these relationships might result in important long-term effects. A longitudinal approach could also be used, for example, to measure over time the implications on adherence for women with false-alarm history. Finally, an important opportunity for future research would involve expanding inquiry beyond mammography. We believe our results are likely to generalize to any stressful testing situation, where screening must be done on a regular basis without the prior presence of symptoms as a motivator. Across additional testing domains, several factors may moderate reactions to false-alarm results. One potential moderator is the event precipitating testing, e.g., the presence of symptoms or the passage of time, as is the case with asymptomatic screening (e.g., mammography). Another potential moderator is the assumed cause of the false-alarm test result. In our studies this was left vague, but it is possible that reactions to false-alarm events will vary with the stated cause of a false-positive test result (e.g., clerical error versus ambiguity in interpretation). In addition, subjects' attributions regarding test errors (e.g., whether the cause of an error is attributed to medical professionals or to the patient) may alter reactions to false-alarm events.

Acknowledgments

The authors thank Emily Conant, M.D., for access to the mammography clinic of the Hospital at the University of Pennsylvania and for verifying the accuracy of our experimental materials. The authors thank Julia Belyavsky, Natalie Bucciarelli, Neena Cohen, Laura Essey, Haben Goitom, Kim Hickey, Jamie Himaya, Rachel Iannucci, Melisa Martinez, Roxanne Miller, Jessica Mills, Ani Ross, Catherine Shao, Maggie Tran, Brittany Walton, Cherry Yan, Christine Yoon, and Angelika Ziberman for invaluable help in data collection. This research was funded by National Science Foundation grant awards #SBR-9320106 and #SBR-9905665 awarded to Barbara E. Kahn and Mary Frances Luce.

Appendix: Scales for Study 2

Adherence: (alpha = 0.80)

1. Do you think you would be more or less likely to get your mammogram at your regularly scheduled time? (1 = less likely, 5 = more likely)

2. Perhaps that question is hard for you to answer because it may be hard for you to anticipate how you will feel when it is

time for your next mammogram. Think about how you feel RIGHT NOW after thinking about the testing experience that we described to you. If you get the results that we said that you got and if you could make your appointment for your next mammogram right now, check the box that most closely matches your feelings RIGHT NOW.

1 = I would probably not schedule another mammogram appointment ever.

2 = I would prefer to put off making the appointment indefinitely.

3 = I would prefer to wait a long time, but I would eventually schedule my appointment for the mammogram.

4 = I would prefer to wait a little while before scheduling my appointment for the mammogram.

5 = I would want to schedule the appointment for the mammogram right now.

3. If you really went through this experience with mammogram test results, do you think that you would get your next mammogram test AS SOON AS you were due for it? (1 = I would not get a mammogram test again, 5 = I would get a mammogram test with no delay)

4. What about if it were possible for you to get your next mammogram test EARLY due to new insurance guidelines. If you really went through this experience with mammogram test results, do you think that you would get your next mammogram test EARLY? (1 = I would not get a mammogram test early, 5 = I would get a mammogram test as early as possible)

5. How likely do you think you will be to have your mammogram tests AS SOON AS you were due for them in the future? (1 = not likely, 5 = very likely)

Stress: (alpha = 0.66)

1. On the scale below, please tell us how stressful it was for you to think about the testing situation we described above. (1 = not stressful at all, 5 = very stressful)

2. On the scale below, how stressful is it for you think about getting breast cancer, after thinking about these test results? (1 = not stressful at all, 5 = very stressful)

3. How stressful would it be for you to make an appointment to get your next mammogram test? (1 = not stressful at all, 5 = very stressful)

4. Prior to taking this study, how much had you thought about breast cancer? (1 = never, 5 = often)

References

Alba, Joseph W. 2000. Presidential address: Dimensions of consumer expertise . . . or lack thereof. Stephen J. Hoch, Robert J. Meyer, eds. *Advances in Consumer Research*, Vol. 27. *Conference Proceedings*, Association for Consumer Research, Columbus, Ohio, 1–7.

Andreasen, Alan R. 1993. Presidential address: A social marketing research agenda for consumer behavior researchers. M. Rothschild, L. McAlister, eds. *Advances in Consumer Research*, Vol. 20. *Conference Proceedings*, Association for Consumer Research, 1–6.

——. 1995. *Marketing Social Change*. Jossey-Bass Publishers, San Franciso, CA.

Audrain, Janet, Barbara K. Rimer, David Cella, Michale Stefanek, Judy Garger, Marie Pennanen, Kathy Helzlsouer, Victor Vogel, Ting Hsiang Lin, Caryn E. Lerman. 1999. The impact of a brief coping skills intervention on adherence to breast self-examination among first-degree relatives of newly diagnosed breast cancer patients. *Psycho-Oncology* **8** 220–229.

Bandura, Albert. 1982. Self-efficacy mechanism in human agency. *Amer. Psychologist* **37** 122–147.

——. 1985. Model of causality in social learning theory. M. J. Mahoney, A. Freeman, eds. *Cognition and Psychotherapy*. Plenum Publishing, New York.

——. 1997. *Self-Efficacy: The Exercise of Control*. W. H. Freeman & C. Publishers, New York.

——, Dale H. Schunk. 1981. Cultivating competence, self-efficacy, and intrinsic interest through proximal self-motivation. *J. Personality and Soc. Psych.* **41** 586–598.

Baron, Jonathan, John C. Hershey. 1988. Heuristics and biases in diagnostic reasoning: I. Priors, error costs, and test accuracy. *Organ. Behavior & Human Decision Processes* **41**(2) 259–279.

Bazerman, Max H. 2001. Consumer research for consumers. *J. Consumer Res.* **27**(4) 499–504.

Burns, Alvin C. 1992. The expanded health belief model as a basis for enlightened preventive health care practice and research. *J. Health Care Marketing* (September) **12** 32–45.

Carver, Charles S., Suzanne D. Harris, Jessica M. Lehman, Lynn A. Durel, Michael H. Anotni, Stacie M. Spencer, Christina Pozo-Kaderman. 2000. How important is the perception of personal control? Studies of early state breast cancer patients? *Personality and Soc. Psych. Bull.* **26**(2) 139–149.

Dube, Laurette. 1996. The role of emotions in health care satisfaction. *J. Health Care Marketing* **16**(2) 45–52.

Elmore, Joann G., Mary B. Barton, Victoria Moceri, Sarah M. Polk, Philip J. Arena, Suzanne W. Fletcher. 1998. Ten-year risk of false positive screening mammograms and clinical breast examinations. *New England J. Medicine* **16**(April) 1145–1146.

Erdem, Tülin, Michael P. Keane. 1996. Decision-making under uncertainty: Capturing dynamic brand choice processes in turbulent consumer goods markets. *Marketing Sci.* **15**(1) 1–21.

Folkman, Susan, Richard S. Lazarus. 1988. Coping as a mediator of emotion. *J. Personality and Soc. Psych.* **54** 466–475.

——, Judith T. Moskowitz. 2000. The context matters. *Personality and Soc. Psych. Bull.* **26**(2) 647–654.

Fyro, K., G. Bodegard. 1987. Four year follow-up of psychological reactions to false positive screening tests for congenital hypothyroidism. *Acta Paediatrics Scandinavia* **16** 107–114.

Gram, Inger Torhild, Suzanne E. Slenker. 1992. Cancer anxiety and attitudes toward mammography among screening attenders, nonattenders, and women never invited. *Am. J. Public Health* **82** 249–251.

Hughes, J. E., G. T. Royle, R. Buchanan. 1986. Depression and social stress among patients with benign breast disease. *British J. Surgery* **73** 997–999.

Inman, J. Jeffrey, James S. Dyer, Jianmin Jia. 1997. A generalized utility model of disappointment and regret effects on post-choice valuation. *Marketing Sci.* **16**(2) 97–112.

Jayanti, Rama K. 1998. The antecedents of preventive health care behavior: An empirical study. *Acad. Marketing Sci. J.* **26**(Winter) 6–10.

Kash, K. M., J. C. Holland, M. S. Halper, D. G. Miller. 1992. Psychological distress and surveillance behaviors of women with a family history of breast cancer. *J. National Cancer Inst.* **84** 24–30.

Koehler, J. J. 1996. The base rate fallacy reconsidered: Descriptive, normative, and methodological challenges. *Behavioral and Brain Sci.* **19** 1–53.

Lazarus, Richard S. 1991. Progress on a cognitive-motivational-relational theory of emotion. *Amer. Psychologist* **46** 819–834.

Lehmann, Donald R. 1989. *Market Research and Analysis*. Richard D. Irwin, Homewood, IL, 12–44.

Lerman, C., M. Daly, C. Sands, A. Balshem, E. Lustbader, T. Heggan, L. Goldstein, J. James, P. Engstrom. 1993. Mammography adherence and psychological distress among women at risk for breast cancer. *J. National Cancer Inst.* **85** 1074–1080.

——, K. Kash, M. Stefanek. 1994. Younger women at increased risk for breast cancer: Perceived risk, psychological well-being, and surveillance behavior. *J. National Cancer Inst. Monographs* **16** 171–176.

——, S. M. Miller, R. Scarborough, P. Hanjani, S. Nolte, D. Smith. 1991a. Adverse psychological consequences of positive cytologic cervix screening. *Amer. J. Obstetrical Gynaecology* **165** 658–662.

——, Barbara K. Rimer. 1993. Psychosocial impact of cancer screening. *Oncology* **7** 67–72.

——, Barbara K. Rimer, Bruce Trock, A. Balshem, Paul F. Engstrom. 1990. Factors associated with repeat adherence to breast cancer screening. *Preventive Medicine* **19**(3) 279–290.

——, E. Ross, Alice Boyce, P. Gorchov, R. McLaughlin, Barbara K. Rimer, Paul Engstrom. 1992. The impact of mailing psychoeducational materials to women with abnormal mammograms. *Amer. J. Public Health* **82**(5) 729–730.

——, Bruce Trock, Barbara K. Rimer, K. Christopher Jepson, D. Brody, Alice Boyce. 1991. Psychological side-effects of breast cancer screening. *Health Psych.* **10** 259–267.

Luce, Mary Frances, Barbara E. Kahn. 1999. Avoidance or vigilance? The psychology of false positive test results. *J. Consumer Res.* **26**(3) 242–259.

——, James R. Bettman, John W. Payne. 1997. Choice processing in emotionally difficult decisions. *J. Experiment. Psych.: Learning, Memory and Cognition* **23**(March) 384–405.

——, ——, ——. 2001. Tradeoff difficulty: Determinants and consequences for consumer decisions. *Monograph J. Consumer Res.* **1**(Spring) 1–209.

Meyer, Robert, Eric J. Johnson. 1995. Empirical generalization in the modeling of consumer choice. *Marketing Sci.* **14**(3) G180–G190.

Moorman, Christine, Erika Matulich. 1993. A model of consumers' preventative health behaviors: The role of health motivation and health ability. *J. Consumer Res.* **20**(September) 208–229.

Morris, J., R. Ingham. 1988. Choice of surgery for early breast cancer: Psychosocial considerations. *Soc. Sci. and Medicine* **27** 1257–1262.

Ofir, Chezy, John G. Lynch, Jr. 1984. Context effects on judgment under uncertainty. *J. Consumer Res.* **11**(September) 668–679.

Oliver, Richard L., Philip K. Berger. 1979. A path analysis of preventive health care decision models. *J. Consumer Res.* **6**(2) 113–114.

Pisano, Etta D., Jo Anne Earp, Tamara Lou Gallant. 1998. Screening mammography behavior after a false positive mammogram. *Cancer Detection and Prevention* **22**(2) 161–167.

Ratchford, Brian T., Narasimhan Srinivasan. 1993. An empirical investigation of returns to search. *Marketing Sci.* **12**(1) 73–88.

Richins, Marsha L. 2001. Presidential address: Consumer behavior as a social science. Mary C. Gilly, Joan Meyers-Levy, eds. *Advances in Consumer Research*, Vol. 28. *Conference Proceedings*, Association for Consumer Research, Salt Lake City, UT, 1–5.

Rimer, Barbara K., Bruce Trock, Paul Engstrom. 1991. Why do some women get regular mammograms? *Amer. J. Preventative Medicine* **7**(2) 69–74.

Rippetoe, Patricia A., Ronald W. Rogers. 1987. Effects of components of protection-motivation theory on adaptive and maladaptive coping with a health threat. *J. Personality and Soc. Psych.* **52** 596–604.

Rosenstock, Irwin M. 1974. Historical origins of the health belief model. *Health Ed. Monographs* **2**(5) 409–419.

——, J. P. Kirscht. 1977. Patient adherence to antihypertensive medical regimens. *J. Community Health* **3**(2) 115–124.

Ross, Lee, Mark R. Lepper, Richard R. Lau. 1986. Persistence of inaccurate beliefs about the self: Perseverance effects in the classroom. *J. Personality and Soc. Psych.* **50**(3) 482–491.

——, ——, F. Strack, J. Steinmetz. 1977. Social explanation and social expectation: Effects of real and hypothetical explanations on subjective likelihood. *J. Personality and Soc. Psych.* **35**(11) 817–829.

Roter, D., J. A. Hall. 1992. Doctors talking with patients/patients talking with doctors. Auburn House, Westport, CT.

Schwartz, M. D., Barbara K. Rimer, Mary Daly, Colleen Sands, Caryn E. Lerman. 1999. Risk counseling: The impact on self-reported mammography use. *Amer. J. Public Health* **89**(6) 924–926.

Sutton, Stephen. 1998. Does breast screening arouse anxiety? *Psych. Health and Medicine* **3**(1) 81–85.

Spiro, D., F. Heidrich. 1983. Lay understanding of medical terminology. *J. Family Practice* **17**(2) 277–279.

Swets, John A. 1986. Indices of discrimination or diagnostic accuracy: Their ROCs and implied models. *Psych. Bull.* **99** 100–117.

Walsh, John W. 1995. Flexibility in consumer purchasing for uncertain future tastes. *Marketing Sci.* **14**(2) 148–166.

Wardle, Jane, Rosemary Pope. 1992. The psychological costs of screening for cancer. *J. Psychosomatic Res.* **36** 609–624.

This paper was received April 20, 2001, and was with the authors 9 months for 4 revisions; processed by Joel Huber.