Effects of Scanning—Routine Health Information Exposure—on Cancer Screening and Prevention Behaviors in the General Population

Authors:

Robert Hornik, Ph.D.†

Sarah Parvanta, MPH†

Susan Mello, MA†

Derek Freres, MA†

Bridget Kelly, Ph.D.#

J. Sanford Schwartz, M.D.§

† Annenberg School for Communication, University of Pennsylvania, Philadelphia, PA, USA

§ Department of Medicine and The Wharton School, University of Pennsylvania, Philadelphia, PA, USA

RTI International, Washington, DC, USA

The authors acknowledge the funding support of the National Cancer Institute's Center of Excellence in Cancer Communication (CECCR) located at the Annenberg School for Communication, University of Pennsylvania (P50-CA095856-05 & P20-CA-095856).

We are grateful to the following members of the Seeking and Scanning Behavior research group who were important contributors to this research program: Katrina Armstrong, MD, Angel Bourgoin, MA, Angela DeMichele, MD, Taressa Fraze, Ph.D., Martin Fishbein, Ph.D. Stacy Gray, MD, Nehama Lewis, MA, Lourdes Martinez, MA, Rebekah Nagler, Ph.D, Jeff Niederdeppe, Ph.D., Susana Ramirez, Ph.D., Anca Romantan, Ph.D., Andy Tan, MBBS.

Address correspondence to Robert Hornik, Annenberg School for Communication, 3620 Walnut Street, Philadelphia, PA 19104, USA. E-mail: rhornik@asc.upenn.edu

Abstract

Research on health information exposure focuses primarily on deliberate *information seeking* behavior and its effects on health. By contrast, this study explores the complementary and perhaps more influential role of health information acquired through exposure to routinely used sources, called *scanning.* We hypothesized that scanning from non-medical sources, both mediated and interpersonal, affects cancer screening and prevention decisions. A nationally representative longitudinal survey of adults 40 to 70 years (N=2,489) was used to analyze the effects of scanning on three cancer screening behaviors (mammography, PSA, colonoscopy) and three prevention behaviors (exercising, eating fruits and vegetables, dieting to lose weight). After adjustment for baseline behaviors and covariates, scanning at baseline predicted one year later weekly exercise days overall, as well as daily fruits and vegetables servings for those already higher on baseline consumption. Also among those reporting timely screening mammogram behavior at baseline, scanning predicted repeat mammography. Scanning was marginally predictive of PSA uptake among those not reporting a PSA at baseline. While there were strong cross-sectional associations, scanning did not predict dieting or colonoscopy uptake in longitudinal analyses. These analyses provide substantial support for a claim that routine exposure to health content from non-medical sources affects specific health behaviors.

Effects of Scanning—Routine Health Information Exposure—on Cancer Screening and Prevention Behaviors in the General Population

People are exposed to a variety of information sources that may influence their subsequent decisions about personal health. In part, these decisions are contingent upon formal interactions with sources in the medical system, principally physicians and other health care providers. However, informal and mediated exposure to information from non-medical sources, including family and friends, the mass media, and the internet also may affect these types of decisions (Mills & Davidson, 2002; Napoli, 2000). For the purposes of this study we categorize exposure to information that does not involve formal direct contact with health care providers as exposure to non-medical sources. A person's exposure to health information from these sources either can be sought deliberately or merely be a consequence of their routine use of media. In general, people who seek information about a particular health issue, such as the benefits of a low-fat diet or the risks associated with certain vaccines, are typically in the middle of making a decision (Johnson, 1997). Sought information often can facilitate decision making and resolve uncertainty. At times, deliberative information seeking can function to ease anxiety or reinforce confidence in a decision that already has been made (Carlson, 2000; Czaja, Manfredi, & Price, 2003; Feltwell & Rees, 2004)

The fundamental hypothesis addressed by this study is whether exposure to information from non-professional medical sources, whether mediated or interpersonal also can affect behavioral outcomes when exposure is less deliberate. Our central premise is that *information scanning* – exposure to health information in the context of routine conversation and use of media – also plays a significant, complementary, and perhaps at times even larger role than information seeking in behavioral decisions related to health.

While a single episode of exposure as the result of deliberate seeking about a topic may be more influential than a single episode of scanned exposure to the same information, scanning about most topics is much more frequent (Niederdeppe et al., 2007; Shim et al., 2006), and involves many more individuals. As a result scanning, in aggregate, may be more influential. Some health topics receive frequent coverage in accessible information sources. For example, the importance of exercise and proper nutrition in mitigating the deleterious effects of obesity on overall health has become ubiquitous in U.S. news. Public service announcements on radio and television encourage routine self-breast exams and screening mammograms and screening for colon cancer. Moreover, people frequently discuss these issues with one another. With minimal effort, most of the population is likely to be exposed to repetitive doses of information about such topics. Repeated exposure, even outside the context of motivated information searching, logically may have a cumulative and substantial impact on behavioral choices (Hornik & Niederdeppe, 2008). Admittedly, this is not a new argument; however, most research on information exposure has focused on deliberate information seeking behavior (e.g., Bright et al., 2005; Muha, et al., 1998; Niederdeppe, Frosch & Hornik, 2008). Our current program of research seeks to capture and understand, more fully, the influence of scanned exposure to health content. We examined scanning from a variety of mediated and interpersonal information sources and assessed the cumulative effect of scanning over time on three cancer screening test behaviors (mammography, PSA, colonoscopy) and three prevention behaviors (exercising, eating fruits and vegetables, dieting to lose weight).

Information Scanning

Over the years, the general concept of scanning has taken a variety of names in the literature: incidental or mere exposure (Bornstein, Leone, Galley, 1987; Janiszewski, 1993;

Obermiller, 1985; Shapiro, MacInnis, & Heckler, 1997; Shapiro, 1999; Tewksbury, Weaver, & Maddex, 2001), incidental information use (Tian & Robinson, 2008), non-strategic information acquisition (Berger, 2002), information yielding (Atkin, 1973), passive learning (Zukin & Snyder, 1984), casual seeking (Johnson, 1997), information or news browsing (Tewksbury, Hals, Bibart, 2008), and passive information seeking (Brashers et al., 2002) among others (e.g., Case, 2002; Griffin, Dunwoody & Newirth, 1999; Krugman & Hartley, 1970; Slater, 1997). The actual term "scanning" became part of the exposure lexicon earlier (i.e., Kosicki & McLeod, 1990; Slater, 1997). In recent years, it has been borrowed by our team and further specified to refer exclusively to "information acquisition that occurs within routine patterns of exposure to mediated and interpersonal sources that can be recalled with a minimal prompt" (Niederdeppe et al., 2007, p. 5). This includes information encountered in a purely incidental manner that received a certain degree of attention, enough to generate some recall of the information at a later time. What scanning excludes is any exposure to information that was not successfully encoded into memory. Such exposure is not possible to measure with the survey-based methods employed by studies in this area (Southwell, Barmada, Hornik, & Maklan, 2002).

Here, we assert that if information scanning indeed matters to personal health, then the mechanism of effect may reflect any or all of three mechanisms: (1) new information acquisition; (2) normative reinforcement; or (3) reminding. First, scanning may increase the probability of exposure to and recall of new information. Information attended to during routine scanning may *describe* associated risks and benefits, the support of specific authorities for the behavior, or even instructions for successfully executing the behavior. Second, scanned exposure may *reinforce* descriptive or subjective norms. If information appears repeatedly across a range of prominent sources, scanning may lead to a normative belief that most others engage in the behavior and/or that the behavior is expected. Finally, scanning may remind a person of the reasons for engaging in a behavior. Repeated exposure to messages may make the reasons more cognitively accessible when a decision to engage or not in a behavior is made. Certain health behaviors that demand higher levels of commitment, like proper diet and exercise, may require recurring reminders of why they are important. Scanning may call to mind the benefits for behaviors without requiring the work or motivated predisposition of seeking.

According to results from the study by Shim et al. (2006), about 80% of respondents in a large, nationally representative survey sample of U.S. adults (HINTS) reported scanning health information from non-medical sources. Our earlier descriptive work with the current data is consistent with this claim, finding scanning about at least one of the six health behaviors examined among 90% of the 40-70 year old population and between 33% and 75% for each of the topics (Kelly et al., 2010). Previous analyses have provided evidence for the validity of our measures of scanning (Kelly, Niederdeppe & Hornik, 2009) as well as for concurrent associations of scanning with the screening and prevention behaviors (Kelly et al., 2010). The multivariate lagged analyses we report here build on this prior work and provide novel evidence consistent with a causal relationship between scanning and certain health behaviors.

Here we test the hypothesis that scanned exposure to behavior-specific mediated and interpersonal content influences adoption of those behaviors. In addition we examine whether those hypothesized effects are contingent on baseline levels of those behaviors. While above we have suggested several mechanisms for these effects, we do not test those mechanisms in this study systematically.

Methods

Sample

The general population survey of seeking and scanning behavior was conducted longitudinally, and invited participation from a representative sample of U.S. adults aged 40 to 70 years. In 2005, a sample of 2,489 participants completed the baseline survey (hereafter referred to as Time 1), and of these, 1,812 completed a follow-up survey one year later (Time 2). The data were collected through the online survey firm, Knowledge Networks, that develops samples through random digit dialing and provides internet access to those who do not have it. Further details about the sampling procedures – as well as measure development and validation – are described elsewhere (Kelly et al., 2009).

Scanning measures (Time 1)

Respondents reported how and how often they scanned for information about the six behaviors examined, including three cancer screening behaviors: mammography (women only), colonoscopy, and prostate-specific antigen (PSA) testing (men only); and three cancer prevention behaviors: exercise, fruit and vegetable consumption, and dieting to lose weight. Briefly, the question sequence began by distinguishing between seeking and scanning ("Some people are actively looking for information about [colonoscopy], while other people just happen to hear or come across such information."). Then participants were asked about their active seeking of information about a topic from specific sources. Finally, participants were asked about scanning behaviors ("Thinking about the past 12 months, did you hear or come across information about [colonoscopy] from doctors, from other people, or from the media even when you were not actively looking for it?"). If they replied positively, they were asked about the frequency of exposure to medical sources and to four categories of non-medical sources: (1) family, friends or co-workers; (2) television or radio; (3) newspapers, magazines or newsletters; and (4) the internet. The medical sources are not included in our analyses since our interest here is in scanning from non-medical sources, which we have defined as exposure that was not the result of formal contact with medical providers. We created a composite measure assessing the frequency with which a respondent recalled seeing information in each of the non-medical sources in the previous 12 months. For each category, respondents received 0 points if they never received information from the sources named, one point if they received information once or twice, and two points if they received information three or more times. Thus, the total scores when summed across the four source categories could range from 0-8 for each of the six behaviors. These total score measures are the independent variables in our analyses. We recognize that these measures likely reflect the breadth of scanning behavior across sources more than they capture the depth of scanning from any single source (since respondents would get no more than 2 points for exposure to a topic through any source).

Outcome Behaviors (Time 1 and Time 2 survey waves)

Descriptions of the measures of cancer screening and prevention behaviors are reported elsewhere (Kelly et al., 2010). Respondents reported whether they had heard of the screening behaviors (PSA and colonoscopy only), and if so, whether they had engaged in the respective screening behaviors and when they were most recently screened (ranging from ≤1 year ago to >5 years ago for PSA and mammography, and ≤10 or >10 years ago for colonoscopy).[1] For each screening behavior, these questions were combined into one dichotomous measure of up to date or not on screening at the time of measurement based on recommended guidelines (Smith, Cokkinides & Eyre, 2006). For mammography and PSA, that meant having had the test in the previous year.[2] Those participants who had reported having had a colonoscopy in the past 10 years were considered up to date at Time 1. Only those who were not up to date at Time 1 were considered eligible for receiving a colonoscopy at Time 2, and were considered up to date at Time 2 if they reported ever having had a colonoscopy.

Respondents also were asked whether they had controlled their diet to lose weight in the previous 30 days (yes, no); how many days per week they exercised on average, if at all; and how many servings of fruit, and separately, vegetables they consumed per day during the previous week, ranging from less than one serving per day to five or more servings per day (coded from 0-5) based on recommended fruit and vegetable intake guidelines (Butrum, Clifford & Lanza, 1988; Doyle et al., 2006). Scores on the fruit and vegetable measures were summed to create a continuous measure of fruit and vegetable consumption ranging from 0-10.

Confounders

We selected different sets of confounders for cross-sectional and lagged regression models for different screening and prevention behaviors. Confounders were defined as belonging to one of two categories: confounders that we could assume were causally prior to both scanning as well as the screening and prevention behaviors; and confounders that were possibly causally prior but also possibly mediators of any influence of scanning on the screening and prevention behaviors. We adjusted for the potential influence of the first group in both cross-sectional and lagged analyses.[3] The second group was included in the lagged analyses only[4] since, if we had adjusted for potential mediators in a cross-sectional analysis, we would have risked underestimating scanning effects.

Analysis

We examined distributions of all variables used in the analyses including confounders (not presented) and scanning behaviors (independent variables) at Time 1, and the six corresponding screening and prevention behaviors (dependent variables) at Time 1 and Time 2. The primary set of analyses uses OLS regression for continuous dependent variables or logistic regression for dichotomous dependent variables. To determine whether information scanning from media and interpersonal sources influences behavior, the following sequence of analyses was performed (in the order of their credibility in supporting causal claims): (1) testing for a cross-sectional relationship between Time 1 behavior and Time 1 scanning; (2) checking whether this relationship remained after adjusting for potential confounders; (3) testing for a lagged association between Time 1 scanning and Time 2 behavior, adjusting for Time 1 behavior; (4) examining any additional effects of the interaction of Time 1 scanning and Time 1 behavior; and finally (5) adjusting for potential confounders of the observed lagged main effect and interactive relationships. In the lagged models, we first adjusted only for the same list of confounders used in the cross-sectional analyses (a less stringent test), and then a longer list that included some variables that could have been either confounders or mediators of the scanning-behavior relationship (a conservative test). If the interaction did not exhibit a significant ($p \leq 0.05$) association with behavior in step 4, it was not included in step 5; but we then added the interaction term back in with a sixth step to determine if the interaction became significant in the full model. This did not happen in any of the models for the six behaviors. We report below the essential results from this set of analyses.

Cases with missing values on any of the independent, dependent, or confounding variables were dropped from the models using listwise deletion. No more than 10%-15% of cases were missing in any analysis. Significance was set at $p \leq 0.05$ for all statistical tests. To help in interpretation of significant interaction terms in the lagged models, we plotted the predicted values of Time 2 behavior by scanning and Time 1 behavior while holding all other covariates constant at their means. All analyses were weighted to adjust the results for this sample to the U.S. population. We used the STATA 10 SVY package to apply post-stratification probability weights to all analyses and to correct estimates of standard errors accordingly (Statacorp, 2007). We used the SUBPOPULATION option with SVY for analyses that included only eligible cases (e.g., the screening mammography analysis included only women). The University of Pennsylvania Institutional Review Board reviewed and approved all study procedures and materials used for this research.

Results

Descriptive analyses

Full sample (unweighted) sociodemographic characteristics at Time 1 are listed in Table 1. The sample was evenly distributed among males and females; the mean age of respondents was about 53 years (SD=8.4). White respondents made up 76% of the sample and black respondents made up about 11%. Most respondents had gone to college (60%), and the mean annual income was about $56,000. All subsequent analyses are weighted to estimates based on the Current Population Survey distributions of primary demographic characteristics.

Weighted distributions for the six scanning items and their corresponding prevention or screening behaviors at Time 1 and Time 2 are listed in Table 2. Participants reported scanning most for information about fruit and vegetable consumption and dieting to lose weight. On average, women reported scanning about screening mammography often while men rarely scanned for information about screening PSA tests. The frequency of performing actual screening and prevention behaviors was relatively stable across the two survey years. Despite the year between measurements and the possibility of true changes in behavior over that time, most correlations between Time 1 and Time 2 behaviors ranged from 0.52 to 0.81; dieting to lose weight was slightly lower at 0.39.

Bivariate and multivariate analyses

Table 3 presents evidence for cross-sectional associations between scanning on a topic and engaging in the related behavior. For five of the six behaviors (colonoscopy, PSA, dieting, exercise, and fruit and vegetable consumption), significant cross-sectional associations were observed. These associations remained after adjusting for a broad set of potential confounders. (Any measured confounder that might have influenced both scanning and behavior at the same time is effectively controlled.) However, a claim that scanning causes the behavior is susceptible (as always with observational data) to another potential threat to inference: the risk of reverse causal direction (that the true mechanism accounting for the association is that those who engage in the behavior are more likely to recall scanning about the behavior).

The next set of analyses examined evidence for a lagged effect, and begins to address the issue of reverse causality (see Table 3). Here, we tested whether scanning at Time 1 was associated with the behavior measured cross-sectionally, but also for behaviors measured one year later with adjustments made for Time 1 behavior levels. First, this allowed us to assess whether scanning preceded behavior in time. Second, by adjusting for Time 1 behavior, we adjusted for all unmeasured potential confounders which affect both scanning and the outcome behavior at the same time (although unmeasured confounders with earlier effects on scanning and delayed effects on behaviors may still threaten inferences of observed effects). Finally, using lagged analyses, we were able to examine whether the effects of scanning differed for those who were and were not engaged in the behaviors at Time 1. To do so, we examined effects on Time 2 behavior of the interaction of scanning and behavior, both measured at Time 1.

We found a significant positive effect of the interaction of Time 1 scanning and Time 1 screening mammography behavior on mammography one year later (see also Figure 1), adjusting for potential confounders of the observed relationship. Namely, among women who were up to date for screening mammography at Time 1, increased scanning predicted increased odds of getting a screening mammogram at Time 2 compared to women who had not had a recent screening mammogram at Time 1. For colonoscopy, there was no evidence of scanning effects on screening behavior in the lagged analysis. (This analysis included only those people who reported not having a colonoscopy at Time 1 because colonoscopy is typically recommended every 10 years, and the Time 2 survey was conducted only one year later.) The PSA analysis required some additional steps to fully assess the effect of scanning on PSA behavior among men. Simple lagged results suggested that scanning predicted PSA screening one year later controlling for PSA behavior at Time 1 (OR=1.27, SE=0.09); the interaction of scanning and PSA was close to but not significant (p = .09). When the full range of confounders were adjusted, however, the main effect was not significant.[5]

Lifestyle prevention behaviors comprise the second group of lagged outcomes. While scanning was significantly associated with dieting to lose weight cross-sectionally, Table 3 shows no robust evidence for a scanning effect on dieting to lose weight one year later. Additional analyses were conducted using only those participants who were overweight or obese (BMI greater than or equal to 25) at Time 1, and were therefore highly eligible to diet. Still, no effect of scanning was observed (analyses not shown). There was, however, evidence for lagged scanning effects on both fruit and vegetable consumption and weekly exercise levels, adjusting for confounders and respective Time 1 behaviors. For fruit and vegetable consumption, the effect of scanning is seen in the interaction. Figure 2 provides some sense of the effects of scanning and its relationship with prior consumption. Increased scanning was associated with an even higher level of fruit and vegetable consumption at Time 2 among those who adhered to recommended guidelines by eating five or more servings of fruit and vegetables per day at Time 1. Scanning did not predict increased fruit and vegetable consumption among those who were not complying with recommendations at Time 1. For exercise behavior, the adjusted lagged results in Table 3 show a simple main effect of scanning. Regardless of prior level of exercise, there is an expected increase of around 0.05 days per week for every 1-unit increase in scanning, or 0.4 additional exercise days comparing those at the lowest and highest levels on the 8-point scanning scale. For fruit and vegetable consumption, among those already consuming at least five servings a day, those with the highest scanning score were increasing consumption 0.16 more servings than those with the lowest score.

Discussion

These analyses provide evidence in support of an association (either cross-sectional, lagged or both) between exposure to non-medical sources of information and each of the six screening and prevention behaviors. Of the six behaviors examined, there also is fairly robust evidence for effects on three – mammography, fruit and vegetable consumption, and exercise – from more exacting analyses which take account of time order and a broad range of confounders. Finally, the PSA analyses showed some inconsistent evidence for lagged effects. The strength of these claims is further enhanced by the fact that they are drawn from a representative U.S. national sample.

As with all analyses based on observational data, the next question is whether all likely threats to inferences based on these results have been addressed. Are there other unmeasured time asymmetric confounders that might have affected scanning earlier and these screening and prevention behaviors later? For example, is it possible that people motivated to change their behavior may be more likely both to attend to information about a topic when it appears through their routine use of sources, and only later to adopt the behavior? This motivation could lead first to scanning and only at a subsequent time to behavior change, consistent with the evidence in Table 3. While motivation is a straightforward example of such asymmetric unmeasured confounders, it is possible that there are others as well. Similarly, we also recognize that our measures of scanning are measures of recall of scanning as is typical for all self-reported measures of exposure; they thus may be subject to the varied biases that recalled exposure measures always face. If some unmeasured covariate is associated with a tendency to recall exposure, and with a tendency to change behavior, then it would create a threat to our claims of influence.

Thus far, this paper has focused on the effects of all forms of non-medical source scanning; however, this merges the effects of distinct behaviors, including the use of interpersonal sources (friends and family), mass mediated sources (television, radio, newspapers, magazines and pamphlets), and the internet (which collapses static web pages with pop-up ads, e-mail and messages on social networking sites, such as Facebook, Twitter and YouTube). The internet is perhaps the most complex category to disentangle, as it can include on-line versions of newspapers, or television news, mediated interpersonal communication between friends and family and even with the doctor. In fact, it is not possible to differentiate effects among these categories of sources. There was a strong association of scanning across these sources. The average Spearman correlation between the individual scanning measures for each behavior was 0.49 and ranged as high as 0.70. On the other hand, when all of the scanning measures were included together, none of them showed a separate significant effect in the same equations. Their multi-collinearity indicates that their effects cannot be separately estimated, which reflects two likely influences – one methodological and one substantive. The way the survey question about scanning was asked, people who indicated they did not obtain information about a topic through scanning overall also were assigned as non-scanners for all sources. This question structure increases the likelihood of correlated error and thus some degree of association. Substantively, the inability to separate effects by source reflects the tendency for those who scanned from one source to scan from the others. The effects of exposure to each individual source are not likely to be distinguishable – news seen on television is likely linked to newspaper articles read and both are likely to be linked to conversations with friends, and all three, albeit to a lesser extent, with a tendency to notice relevant material online.The introduction to this article offered three mechanisms for the possible influence of scanning from non-media sources on adoption of new health behaviors: (1) increased opportunities to learn the benefits of new behaviors (and possibly their risks); (2) implicit reinforcement of a descriptive norm; and (3) reminder of the reasons for doing the behavior when the behavior requires committed repetition. Unfortunately, the data available from the survey do not permit full exploration of these paths of possible effect. We have measures of the belief that each of these behaviors is common among peers of the respondent for the three screening measures. There is a significant association of scanning with the belief that peers are getting all three screening tests, at the same time for all three tests (correlations of 0.155, 0.173 and 0.128 for colonoscopy, mammography and PSA, respectively) and on a lagged basis, adjusting for Time 1 perception of the descriptive norm for colonoscopy and mammography, prediction of Time 2 descriptive norm by scanning at Time 1 (betas of 0.102 and 0.094). These are not large effects, but they are consistent with the second described mechanism of effect. Clearly there is much work left to be done in the elucidation of mechanisms of effect.

A final issue is why lagged effects are found for some behaviors but not others, or why effects sometimes differ contingent on Time 1 behavior. We had no a priori hypotheses about these relationships, and do not see a consistent pattern among them. Importantly, however, there was some evidence for each behavior examined for effects, either cross-sectional or in the lagged analyses for either a main effect or an interaction with prior behavior. It could be that there are inherent differences in the behaviors which make some responsive to the immediate influence of scanning and others to longer term effects as well. To address this speculation empirically, future research may benefit from further conceptualizing measurement lags for different cancer prevention and detection behaviors. However, it is also worth recalling that this differentiation may be unnecessary; the chief value of the lagged analysis with complete confounder adjustment is methodological, to reduce the credibility of threats to causal inference. The significant lagged results thus provide the strongest evidence for scanning effects on behavior, but both cross-sectional and lagged analyses are relevant to describing the likely magnitude of the substantive relationship between scanning and behavior.

In summary, we have clear evidence for the cross-sectional and some evidence for the prospective longitudinal associations of scanning of non-medical sources with specific health behaviors. Furthermore, there is evidence that this effect remains after adjustment for a range of potential confounding influences. We cannot differentiate which of the sources are particularly important in this process, nor can we distinguish mechanisms of effect. Nonetheless, these analyses lend considerable support to the argument that scanning (exposure to health information through routine use of sources of information) leads to adoption or maintenance of health behaviors at a population level. Because even small individual effects felt on a population level mean substantial public health benefit, these effects are worth attention and further study.

References

Atkin, C. K. (1973). Instrumental utilities and information seeking. In P. Clarke (Ed.), *New models for communication research* (pp. 205-242). Beverly Hills: Sage.

Berger, C. R. (2002). Strategic and nonstrategic information acquisition. *Human Communication Research, 28*, 287-297.

Bornstein, R. F., Leone, D. R., & Galley, D. J. (1987). The generalizability of subliminal mere exposure effects: Influence of stimuli perceived without awareness on social behavior. *Journal of Personality and Social Psychology, 53,* 1070-1079.

Brashers, D. E., Goldsmith, D. J., Hsieh, E. (2002). Information seeking and avoiding in health contexts. *Human Communication Research, 28,* 258-272.

Bright, M. A., Fleisher, L., Thomsen, C., Morra, M. E., Marcus, A., & Gehring, W. (2005). Exploring e-Health usage and interest among cancer information service users: The need for personalized interactions and multiple channels remains. *Journal of Health Communication, 10*(S1), 35-52.

Butrum, R. R., Clifford, C. K., & Lanza, E. (1988). NCI dietary guidelines: rationale. *The American Journal of Clinical Nutrition, 48*(3 Suppl), 888-895.

Carlson, M. (2000). Cancer patients seeking information from sources outside the health care system. *Support Care Cancer, 8,* 437-438.

Case, D. O. (2002). *Looking for information: A survey of research on information seeking, needs, and behavior*. San Diego, CA: Academic Press.

Czaja, R., Manfredi, C., & Price, J. (2003). The determinants and consequences of information seeking among cancer patients. *Journal of Health Communication, 8*, 529-562.

Doyle, C., Kushi, L. H., Byers, T., Courneya, K. S., Demark-Wahnefried, W., Grant, B., . . . Andrews, K. S. (2006). Nutrition and physical activity during and after cancer treatment: An American Cancer Society guide for informed choices. *CA: A Cancer Journal for Clinicians*, *56*(6), 323-353.

Dutta-Bergman, M. J. (2004). Primary sources of health information: Comparisons in the domain of health attitudes, health cognitions and health behaviors. *Health Communication, 16*, 273-288.

Feltwell, A., Rees, C. (2004). The information-seeking behaviours of partners of men with prostate cancer: a qualitative pilot study. *Patient Education and Counseling*, *54*(2), 179-185.

Fishbein, M., & Ajzen, I. (2010). *Predicting and changing behavior: The reasoned action approach*. New York: Psychology Press.

Griffin, R. J., Dunwoody, S., & Neuwirth, K. (1999). Proposed model of the relationship of risk information seeking and processing to the development of preventive behaviors. *Environmental Research, 80*, S230-S245.

Hornik, R., & Niederdeppe, J. (2008). Information scanning. In W. Donsbach (Ed.), *International encyclopedia of communication* (pp. 2257-2261). Oxford, UK & Malden, MA: Wiley-Blackwell.

Janiszewski, C. (1993). Preattentive mere exposure effects. *Journal of Consumer Research, 20,* 376-393.

Johnson, J. D. (1997). *Cancer-related information seeking.* Cresskill, NJ: Hampton Press.

Kelly, B. J., Niederdeppe, J., & Hornik, R. C. (2009). Validating measures of scanning information exposure in the context of cancer prevention and screening behaviors. *Journal of Health Communication, 14*(2), 721-740.

Kelly, B., Hornik, R., Romantan, A., Schwartz, J.S., Armstrong, K., DeMichele, A., Fishbein, M., Gray, S., Hull, S., Kim, A., Nagler, R., Niederdeppe, J.D., Ramirez, A., Smith-McLallen, A., and Wong, N. (2010) Cancer information scanning and seeking in the general population. *Journal of Health Communication, 15*(7), 734-753.

Kosicki, G. M., & McLeod, J. M. (1990). Learning from political news: Effects of media images and information processing strategies. In S. Kraus (Ed.), *Mass communication and political information processing* (pp. 69-83). Hillsdale, NJ: Lawrence Erlbaum.

Krugman, H. E. & Hartley, E. L. (1970). Passive learning from television. *The Public Opinion Quarterly, 34*(2), 184-190.

Mills, M. E., Davidson, R. (2002). Cancer patients' sources of information: use and quality issues. *Psycho-oncology, 11,* 371-378.

Muha, C., Smith, K. S., Baum, S., Ter Maat, J., & Ward, J. A. (1998). The use and selection of sources in information seeking: The Cancer Information Service experience. Part 8. *Journal of Health Communication, 3,* 109-120.

Napoli, P. M. (2000). Consumer use of medical information from electronic and paper media: a literature review. In R. E. Rice & J. E. Katz (Eds.). *The Internet and health communication: experiences and expectations* (pp. 79-98). Thousand Oaks, CA: Sage.

Niederdeppe, J., Frosch, D. L., Hornik, R. C. (2008). Cancer news coverage and information seeking. *Journal of Health Communication, 13*(2), 181-199.

Niederdeppe, J., Hornik, R. C., Kelly, B. J., Frosch, D. L., Romantan, A., Stevens, R., et al. (2007). Exploring the dimensions of cancer-related information seeking and scanning behavior. *Health Communication, 22*(2), 153-167.

Obermiller, C. (1985). Varieties of mere exposure: The effects of processing style and repetition on affective response. *Journal of Consumer Research, 12,* 17-30.

Shapiro, S. (1999). When an ad's influence is beyond our conscious control: Perceptual and conceptual fluency effects caused by incidental ad exposure. *Journal of Consumer Research, 26*, 16-57.

Shapiro, S., MacInnis, D. J., & Heckler, S. E. (1997). The effects of incidental ad exposure on the formation of consideration sets. *Journal of Consumer Research, 24,* 94-105.

Shim, M., Kelly, B., & Hornik, R. (2006). Cancer information scanning and seeking behavior is associated with knowledge, lifestyle choices, and screening. *Journal of Health Communication, 11*(Supplement 1), 157-172.

Slater, M. D. (1997). Persuasion processes across receiver goals and message genres. *Communication Theory, 7*, 125-148.

Smith, R. A., Cokkinides, V., Eyre, H. J. (2006). American Cancer Society guidelines for the early detection of cancer. *CA: A Cancer Journal for Clinicians*, *56,*11-25.

Southwell, B. G., Barmada, C. H., Hornik, R. C. & Maklan, D. M. (2002). Can we measure encoded exposure? Evidence from a national campaign. *Journal of Health Communication, 7,* 445-453.

Tewksbury, D., Hals, M. L., & Bibart, A. (2008). The efficacy of news browsing: The relationship of news consumption style to social and political efficacy. *Journalism & Mass Communication Quarterly*, *85* (2), 257-272.

Tewksbury, D., Weaver, A. J., & Maddex, B. D. (2001). Accidentally informed: Incidental news exposure on the world wide web. *Journalism and Mass Communication Quarterly, 78,* 533.

Tian, Y. & Robinson, J. D. (2008). Incidental health information use and *media complementarity*: A comparison of senior and non-senior cancer patients. *Patient Education and Counseling*, *71*(3), 340-344.

Zukin, C. & Snyder, R. (1984). Passive learning: When the media environment is the message. *The Public Opinion Quarterly*, *48*, 629-638.

Footnotes

[1] Colorectal cancer screening can be accomplished ordinarily in one of three ways: colonoscopy every 10 years, sigmoidoscopy every five years, or fecal occult blood test (FOBT) annually. Our screening measure assessed colonoscopy only, partly because at the time of this research it was considered the gold standard, and partly because we were constrained by questionnaire space. Thus, although colonoscopy is the predominant form of screening for colorectal cancer in the U.S., we may have risked underestimating the degree of colorectal screening, overall. However, since our scanning measures also were about colonoscopy only, they matched the behavioral measures. We then are likely to underestimate any effects of colonoscopy scanning and colorectal screening other than colonoscopy. Thus, our tests of effects, in all probability, are conservative.

[2] Some guidelines for PSA and mammography screening changed since the Time 1 and Time 2 surveys took place. To accurately represent recommended behavior during that period, analyses herein are consistent with screening guidelines that existed between 2004 and 2006.

[3] Age and age squared; education; gender; race/ethnicity; marital status; employment status; income and dual income; having kids under 18 years old; type, size, head, and ownership status of household; smoking behavior; overall health status; owning web television; living in a large city; use of newspaper, national news, local news, email, internet; body mass index and body mass index squared; history of breast, prostate, colon, and/or other cancers among friends or family; personal history of cancer; religious attendance.

[4] Knowledge of cholesterol levels; knowledge of heart disease risk among men; knowledge of genetic disease inevitability; belief in cancer myths about surgical treatments and cures; health orientation; cancer fatalism. To reduce loss of degrees of freedom, some potential

confounders were excluded from particular models if there was not any observed bivariate relationship with the specific scanning or behavioral measure. Perceived relative risk for breast/prostate cancer was included in the mammography, colonoscopy, and PSA models only; perceived relative risk for colon cancer was not included in the PSA or exercise models; perceived relative risk for other cancers was not included in the PSA model; locus of control in treatment decisions was included in the fruit and vegetable, dieting, and exercise models only; locus of control in lifestyle and cancer screening decisions were not included in the mammography or PSA models; frequency of doctor consultations was not included in the mammography model.

[5] A reduced model including the interaction and only those confounders that added some predictive power to the equation (utilizing backwards stepwise regression and eliminating variables that did not have a $p < .10$) exhibited a significant lagged simple main effect of scanning [OR = 1.18, SE = .09, $p = .036$].

Table 1

Sociodemographic Characteristics of the Sample (N=2,489)[a]

	%	Mean (SD)
Age		52.9 (8.4)
Female	51.2	
Race/ethnicity		
White (not Hispanic)	76.5	
Black (not Hispanic)	10.8	
Hispanic	7.2	
Other	5.6	
Education		
< High school	9.8	
High school	30.5	
College and above	59.7	
Income, thousands		56.10 (40.3)
Married	59.4	

Note. Data are unweighted.

[a] Using Time 1 survey data.

Table 2

Weighted Distributions of Information Scanning from Media and Interpersonal Sources (IV) and Cancer Screening and Prevention Behaviors (DVs)

	Time 1[b]		Time 2[c]		
	N		N		
Scanning,[a] Mean sources in the past 12 months (SD)					
Mammography (*females*)	1,273	2.53 (2.30)			
Colonoscopy	2,471	1.71 (2.00)			
PSA (*males*)	1,199	0.98 (1.68)			
Dieting to lose weight	2,471	3.52 (2.79)			
Fruit and vegetable consumption	2,481	3.20 (2.63)			
Exercise	2,481	3.63 (2.66)			
Behavior					
Mammography, % yes in the past year	1,268	53.8	927	53.5	
Colonoscopy, % ever	2,482	38.5	1,812	41.0	
PSA, % yes in the past year	1,205	26.8	867	30.8	
Dieting to lose weight, % yes in the past 30 days	2,485	38.0	1,812	36.0	
Fruit and vegetable consumption, Mean per day (SD)	2,462	3.65 (2.35)	1,804	3.60	(2.39)
Exercise, Mean days per week (SD)	2,475	2.58 (2.19)	1,805	2.59	(2.16)

Note. Cases (N) and percentages represent non-missing data and are weighted to the population or subpopulation size.

[a] The scanning measure is an 8-point index of media and interpersonal sources.

[b] Weighted according to the Time 1 sample.

[c] Weighted according to the Time 2 sample.

Table 3

Logistic and Linear Regressions of 6 Cancer Screening or Prevention Behaviors on Information Scanning from Media and Interpersonal Sources

	Time 2 Behavior																	
	Mammography			Colonoscopy			PSA			Dieting to lose weight			Fruit and vegetable			Exercise		
Model	N	*OR*	(SE)	N	*OR*	(SE)	N	*OR*	(SE)	N	*OR*	(SE)	N	*b*	(SE)	N	*b*	(SE)
Cross-sectional[a]																		
Scanning	1,130	1.02	(0.04)	2,186	1.12***	(0.03)	1,061	1.14*	(0.06)	2,186	1.08***	(0.02)	2,166	0.19***	(0.02)	2,189	0.04*	(0.02)
Longitudinal 1[b]																		
Scanning	913	0.97	(0.06)	1,111	0.995	(0.06)	856	1.27***	(0.09)	1,800	1.05	(0.03)	1,779	-0.002	(0.03)	1,790	0.02	(0.03)
Behavior		6.55***	(1.88)		-	-		15.95***	(4.02)		6.30***	(1.44)		0.52***	(0.05)		0.57***	(0.05)
Scanning × Behavior		1.20*	(0.10)		-	-		0.83	(0.09)		0.95	(0.04)		0.03**	(0.01)		0.01	(0.01)
Longitudinal 2[c]																		
Scanning	801	0.90	(0.06)	948	0.97	(0.07)	751	1.09	(0.08)	1,567	0.999	(0.03)	1,554	-0.01	(0.04)	1,562	0.05*	(0.02)
Behavior		5.56***	(1.79)		-	-		8.98***	(2.39)		4.83***	(0.72)		0.53***	(0.04)		0.55***	(0.03)
Scanning × Behavior		1.28**	(0 .12)		-	-		--	--		--	--		0.02**	(0.01)		--	--

Note. All predictors are measured at Time 1. N = weighted size of the population or subpopulation; *OR* = odds ratio; *b* = unstandardized regression coefficient; SE = standard error.

[a] Effect of Time 1 scanning on Time 1 screening/prevention behavior, conditional on 33-34 applicable confounders.

[b] Effect of Time 1 scanning on Time 1 screening/prevention behavior at Time 2, conditional on Time 1 screening/prevention behavior and its interaction with scanning.

[c] Effect of scanning at Time 1 on prevention behaviors at Time 2, conditional on Time 1 screening/prevention behavior, its interaction with (if significant in Longitudinal Model 1), and 45-49 applicable confounders.

- Longitudinal models for Colonoscopy included only those cases that reported not having had a colonoscopy at Time 1 and were eligible for screening. This led to no variation in Time 1 behavior. As a result, interactions with Time 1 behavior could not be examined.

-- If the interaction term was not significant in the Longitudinal 1 model, the term was removed from the full model adjusted for confounders.

$^{*}p \leq .05$. $^{**}p \leq .01$. $^{***}p \leq .001$.

Figure 1. Interactive Effects of Time 1 Scanning and Mammography Screening Status on the Predicted Probability of Mammography Screening at Time 2.

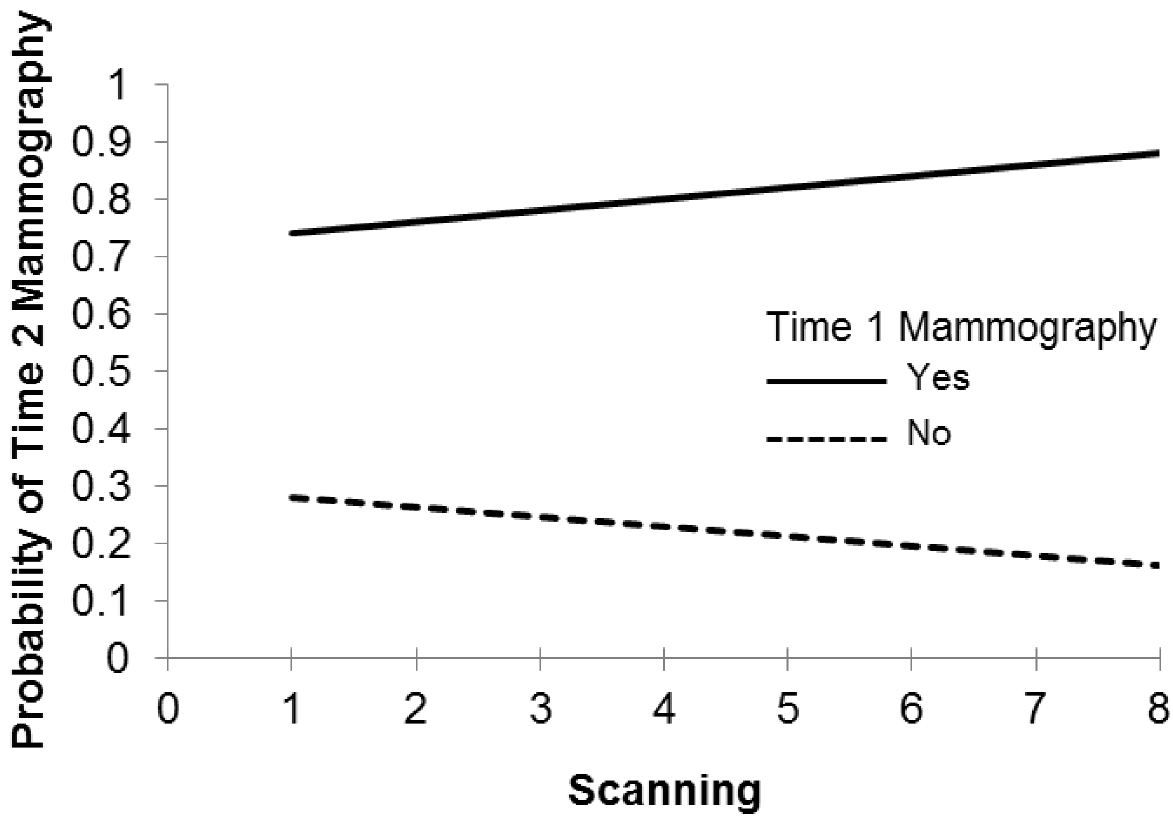

Figure 2. Interactive Effects of Time 1 Scanning and Adherence to Fruit and Vegetable Consumption Recommendations ("5-a-Day") on Predicted Fruit and Vegetable Consumption at Time 2.