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Predicting Colorectal Cancer Screening among Adults Who Have Never Been Screened: Testing the Interaction between Message Framing and Tailored Risk Feedback

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Abstract

Providing adults tailored risk estimates of getting colorectal cancer (CRC) can increase screening. A concern is that receipt of lower risk estimates will demotivate screening; this effect may be curbed by matching level of risk with message framing. Theoretically, pairing lower risk estimates with gain-frame messages, and higher risk estimates with loss-frame messages, should increase screening and screening intentions more than pairing lower risk estimates with loss-frame messages/higher risk estimates with gain-frame messages. These effects may be mediated by how screening is construed (e.g., to find health problems vs. to reaffirm one is healthy). These predictions were tested experimentally among 560 men and women ages 50–75 who have never screened. Participants at baseline received online a tailored comparative risk estimate with gain- or loss-frame information on screening. Screening was assessed six months later. Among the 400 reached at six months, 9.5% reported screening. There were no main effects or interactions between risk feedback and framing predicting construals, screening intentions, or screening. Worry about getting CRC and screening intentions predicted screening. While hypothesized interactions were not found, future research should explore further mechanisms through which online interventions utilizing risk feedback and framing motivate screening among adults who have never screened.

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Conflict of Interest Statement

The authors declare that they have no conflict of interest.

Keywords

Colorectal Cancer Screening; Message Framing; Risk Communication

Introduction

Colorectal cancer (CRC) is the third leading cause of cancer death among men and women in the United States (U.S.) (Lin et al., 2016). Fortunately, screening for CRC via guaiac and immunochemical-based fecal occult blood tests (FOBT/FIT), sigmoidoscopy (SIG) and colonoscopy saves lives (Lin et al., 2016). Thus, major health organizations such as the American Cancer Society and the U.S. Preventative Services Task Force (USPSTF) have put forth screening guidelines (Smith et al., 2016; USPSTF, 2016). Among asymptomatic men and women at average risk between the ages of 50 to 75, the USPSTF screening guidelines include FOBT/FIT every three years, SIG every five or ten years with annual FOBT, colonoscopy every ten years, or virtual colonoscopy every five years. As of 2015, about 38% of the U.S. population did not follow the USPSTF guidelines (White et al., 2017).

A key population to target are individuals 50 and older who have never screened. To this end, based on theories of health behavior change (Janz & Becker, 1984; Weinstein, 1988) being informed that one is at higher CRC risk should increase a person's risk appraisals (e.g., perceived risk and worry) resulting in stronger intentions to screen and screening. Risk appraisals motivate and promote behavior change in many health domains, including CRC screening (Atkinson, Salz, Touza, Li, & Hay, 2015; Sheeran, Harris, & Epton, 2014). The public can learn about CRC screening and their CRC risks using available online algorithms, such as "Your Disease Risk" (YDR), that provide tailored CRC risk (Colditz, 2000; Kim, Rockhill, & Colditz, 2004).

A concern is that receipt of lower risk estimates online will demotivate screening. Yet, when paired with appropriately matched persuasive messages, estimates of lower and higher risk may motivate screening. As argued herein, pairing tailored CRC risk feedback with messages that highlight the benefits of screening (i.e., gain-frame) or the costs of not screening (i.e., loss-frame), respectively, may be a potent combination to promote screening (Gallagher & Updegraff, 2012; Rothman, Martino, Bedell, Detweiler, & Salovey, 1999). According to Prospect Theory (Kahneman & Tversky, 1979), people faced with uncertain losses are risk seeking; they pursue risky behaviors to avoid losses. Loss-framed messages promote this reaction. In this context, screening is risky because an abnormality may be found. Loss-framed messages should be more persuasive than gain-framed messages. Conversely, faced with a certain benefit, people are risk averse and pursue actions to preserve this outcome. In this context, people may be persuaded more by gain- than loss-framed messages.

A person's unique construal of the purpose of screening – as health affirming *or* illness detecting – should be related to their personal risk beliefs and also influence their responsiveness to gain- or loss-framed messages (Bartels, Kelly, & Rothman, 2010; Gallagher, Updegraff, Rothman, & Sims, 2011). That is, people informed and who agree they are at higher CRC risk should construe the purpose of CRC screening as to detect a

problem, and should view it as risky because of the higher chance of finding an abnormality. Accordingly, higher risk feedback combined with loss-frame messages can promote screening because CRC is seen as risky. Screening serves to validate higher risk and, if need be, act to lower the risk (Bartels et al., 2010). Alternatively, for people who are informed of being at average and especially low risk, the purpose of screening may be construed as to affirm one's health (Bartels et al., 2010). In this scenario, pairing lower risk estimates with gain-framed messages may be more persuasive because screening is less risky and likely to confirm one's lower risk status.

Although correlational support exists for the above hypothesized interaction between people's *pre-existing health risk beliefs* and message framing (Apanovitch, McCarthy, & Salovey, 2003; Gallagher et al., 2011; Hull, 2012), no research has tested experimentally the match between tailored CRC risk feedback and message framing to influence CRC screening intentions and screening. One study examined the interaction between pre-existing risk beliefs and message framing; the predicted interaction on CRC screening *intentions* was found (Ferrer, Klein, Zajac, Land, & Ling, 2012). Because framing effects often occur in the context of interactions (i.e., moderators) (Covey, 2014; Updegraff & Rothman, 2013), we tested whether receipt of tailored CRC risk feedback (e.g., above average, average, and below average) would interact with framing to predict intentions and CRC screening.

In addition to testing effects of the risk level by framing interaction and construals on screening, we examined the role of efficacy beliefs. Interventions that can both influence risk appraisals and efficacy beliefs, such as self-efficacy, are likely produce larger effects on intentions and health behaviors (Sheeran et al., 2014). For example, many adults view the preparatory procedures for screening (e.g., cleansing the bowels for sigmoidoscopy/ colonoscopy, setting an appointment) as barriers (Jones, Devers, Kuzel, & Woolf, 2010). People who feel they can overcome these barriers (i.e. high self-efficacy) are more likely to screen (McQueen et al., 2007; Murphy et al., 2014; Vernon et al., 2010). Further, screening tests vary in their ability to find CRC (i.e., response efficacy); higher perceived response efficacy of screening tests is predicted to increase screening intentions and uptake. We examined how self- and response efficacy influenced motivation and uptake of screening.

We enrolled a representative sample of men and women ages 50–75 who never screened for CRC. Based on responses to key risk factors for CRC, these men and women were given tailored comparative (self vs. other) risk feedback online. Within each level of risk feedback, participants received educational materials on CRC screening that varied gain- or loss-frame content. Six months later, screening uptake was assessed. We tested the following main hypotheses:

H1: There will be an interaction between level of risk feedback and message framing on screening intentions and screening. Participants who receive feedback of lower risk with gain- frame messages or feedback of higher risk with loss-frame messages will report stronger screening intentions and achieve higher screening rates than participants who receive feedback of higher risk with gain-frame messages or feedback of lower risk with loss-frame messages.

H2A: Participants who receive feedback of lower CRC risk will construe screening as less risky (e.g., believe they are less likely to find an abnormality) than participants informed they are at higher CRC risk, who will construe screening as more risky.

H2B: Construals will mediate effects of the risk feedback by message framing interaction on screening intentions and screening. Hence, we expected construals would correlate with screening intentions and predict screening.

H3: Higher risk appraisals, self- and response-efficacy will be positively related to screening intentions and screening uptake.

Methods

Overview: Study details have been reported elsewhere (Lipkus, Johnson, Amarasekara, Pan, & Updegraff, 2018). Briefly, potential participants were aged 50 to 75 who were panel members for the professional organization, Growth for Knowledge (GfK). Panel members who self-reported never having had CRC screening via colonoscopy/virtual colonoscopy, SIG, or FOBT/FIT were eligible. Upon consent and completing an online survey on CRC risk factors, participants received a tailored comparative risk estimate and reacted to their risk feedback. Participants were stratified by level of comparative risk and within each level randomized to receive either gain- or loss-framed information on CRC screening. Participants then completed measures that included efficacy beliefs and screening intentions. Six months later, GfK contacted participants to assess screening. The Duke University Medical Center IRB approved this study.

Eligibility and recruitment.—Potential participants were recruited from GfK's Knowledge Networks online panel, a panel representative of the U.S. population, providing sampling coverage of 97% of the U.S. adult population via address-based sampling. A random sample of panelists who met the age criteria was approached and provided a study description. Those interested completed a screener. Eligible participants with no history of screening or CRC consented and answered questions used to generate the tailored CRC risk estimate.

Risk assessment and feedback.—At baseline, participants answered questions about their CRC risk factors used to create a tailored comparative risk estimate per the Your-Disease-Risk Algorithm (Kim et al., 2004). Participants then received the following message, “Based on your answers, on top of the next page you will get YOUR ESTIMATED RISK of getting colorectal cancer in the next 10 years compared to others your sex and age.” Mimicking the risk presentation format of the Your-Disease-Risk website, participants were given a risk estimate that took on one of seven levels “Very much below average”, “Much below average”, “Below average”, “Average”, “Above average”, “Much above average”, and “Very much above average.” The estimate was highlighted by pointing to it on a colored vertical bar; the bar became increasingly green with lower risk estimates, increasingly red with higher risk estimates, and yellow for average risk. Participants were informed as to which factors increased and decreased their CRC risk. After participants received this

information, we assessed their risk appraisals and reactions (e.g., accuracy and emotional reactions) to the risk estimate.

Message framing: After assessing risk appraisals and reactions to the risk estimates, participants were stratified by their level of comparative CRC risk. Within each level, participants randomly received either gain- or loss-framed 8-page educational information on CRC screening. Topics covered included risks of getting CRC, screening tests with their benefits and limitations (e.g., prep for screening), and insurance coverage. Each condition had gain- and loss-framed messages integrated within the content with a final summary of benefits (gain-frame) of screening or costs (loss-frame) of not being screened (see Table 1). Participants then completed measures of efficacy belief, construal of screening, and screening intentions.

Baseline Measures

Framing manipulation check: Effectiveness of framing was assessed by, “Did the messages you just read talk more about the bad things that can happen if you don’t get screened, or more about the good things that can happen if you do get screened for colorectal cancer?” (1= Talked about **BAD** things that can happen if you **DON’T** get screened to 7= Talked about the **GOOD** things that can happen if you **DO** get screened).

Construal of screening: Was assessed using two questions: (1) “What is the main reason you would get colorectal cancer screening?” (1= To find my health problems to 7= To make sure that I am healthy); and (2) “If you get screened for colorectal cancer, how likely is it that a problem will be found?” (1=Extremely unlikely to 7=Extremely likely). The two items were uncorrelated ($r=.05$, $p<.23$).

Risk appraisals.—Consistent with the notion that risk appraisals capture emotions and cognitions about risk (Sheeran et al., 2014), this variable assessed these attributes using six items. For example, we assessed comparative risk (“What do you think is your chance of getting colorectal cancer in the next 10 years compared to the average person your age and sex?”), verbal and numerical absolute risk (“What do you think is your chance of getting colorectal cancer in the next 10 years?”), and worry (e.g., “How worried are you about getting colorectal cancer in the next 10 years?”) – see Lipkus and colleagues (2018) for details. All items loaded on one component that explained 60% of the variance. We created a *composite risk appraisal score* for each participant by using the Proc Score, a SAS procedure, to derive a linearly transformed weighted average of the six-items.

Efficacy beliefs: Self-efficacy was assessed by “How confident are you that you can undergo the following screening tests: FOBT, sigmoidoscopy, colonoscopy, and combining FOBT and sigmoidoscopy?” Each test was rated from 1=Not very confident to 7=Very confident. Response efficacy was assessed by, “How effective are these screening tests at finding colorectal cancer: FOBT, sigmoidoscopy, colonoscopy, and combining FOBT and sigmoidoscopy?” Each test was rated from 1=Not very effective to 7=Very effective. Based on principal components analysis, all self-efficacy and response-efficacy items loaded on one component that explained 85% and 72% of the variance, respectively, with loadings > .

73. The four items for each efficacy belief were summed and averaged (Cronbach's $\alpha = .94$ for self-efficacy, Cronbach's $\alpha = .87$ for response efficacy). The two efficacy beliefs correlated at $r = .43$ ($p < .001$).

Screening intention.—This was assessed using three questions: (1) “Do you intend to get screened for colorectal cancer in the next six months?” (1 = Definitely no to 7 = Definitely yes); (2) “How do you feel about getting screened for colorectal cancer in the next six months?” (1 = Very negative to 7 = Very positive); and (3) “Do you intend to talk to a doctor about colorectal cancer screening in the next six months?” (1 = Definitely no to 7 = Definitely yes). All items loaded on one component, explaining 88% of the variance, with loadings $> .92$. Items were summed and averaged (Cronbach's $\alpha = .92$).

The main screening outcomes at the six-month follow-up are as follows.

CRC screening.—Participants reported whether they screened for CRC within the last six months (no/yes). Those who did not screen were asked if they: (1) talked to a doctor within the last six months about CRC screening (no/yes); and (2) made an appointment to undergo CRC screening in the next six months (no/yes).

Statistical analyses: Descriptive statistics were used to describe sample characteristics and distributions of comparative risk. Associations among interval variables were examined using the Pearson correlation; associations between categorical variables were assessed using Pearson chi-square; and associations between ordinal variables were computed using the Mantel Haenszel (MH) chi-square with one degree of freedom. Two-way ANOVA, simple linear and multiple linear regression analyses were utilized to model continuous outcomes while logistic regression was utilized to model CRC screening. To test for interactions between framing and tailored risk feedback, we collapsed the feedback into three tiers: below average risk, average risk, and above average risk. None of the demographic variables (age, gender, race, education, insurance/marital/employment status) predicted screening and hence will not be discussed further.

Analyses were conducted using SAS/STAT software (version 9.3, SAS System for Windows, SAS Institute Inc., Cary, NC, USA, 2010). SAS survey procedures: proc surveyreg, proc surveymeans, proc surveylogistic and proc surveyfreq were utilized to adjust sampling weights. All analyses were two-tailed with a $p < .05$ deemed as statistically significant.

Results

Sample characteristics:

At baseline, 560 participants were eligible. Of these, 400 (71%) completed the six-month follow-up. Table 2 presents the demographic profiles. As sensitivity analysis, we examined whether those lost to follow-up differed at baseline from those who completed follow-up on demographics, risk appraisals, tailored comparative risk estimate, construals, screening intention, efficacy beliefs, and proportion who received a gain- or loss-framed brochure. Only screening intention differed. Participants who completed follow-up had higher

screening intentions than those lost to follow-up ($M=4.08$ vs. 3.69 , $p<.05$). At baseline about 38% of the sample received a below average comparative risk estimate, about 7% were at average comparative risk, and 55% were at above average comparative risk.

Manipulation check of framing.

At baseline, 281 participants were randomized to loss-frame information and 279 to gain-frame information. The manipulation of framing was successful. Individuals who received the gain-frame information viewed it as covering more the good things that can happen if you got screened than the bad things that can happen if you did not get screened compared to individuals who received the loss-frame information ($M=5.65$ vs. $M=4.60$, $p<.0001$). There was no main effect or interaction with level of risk feedback on the manipulation check.

Interaction of frame and risk feedback predicting screening intentions:

We hypothesized that individuals informed of being at lower risk who received gain-frame information as well as those informed of being higher risk who received loss-frame information would report higher screening intentions than the opposite pairings. As shown at the top of Table 3, no interaction was found, nor any main effects for framing or level of risk feedback.

Interaction of frame and risk feedback predicting construals:

We predicted individuals informed of being at above average risk who received loss-frame information would: 1) report the main reason for screening would be to find health problems; and 2) expect to find problems if screened. We expected the opposite pattern among participants informed they were at average and especially lower risk and received gain-frame information. As shown in the middle of Table 3, there were no significant main effects or interactions for either outcome. As reported in Lipkus et al (2018), the correlation between the comparative risk estimate and a person's CRC risk appraisal was $r = .34$, $p<.001$, suggesting that not all participants internalized their risk estimate. Accordingly, we conducted an analysis replacing tailored risk feedback with the composite risk appraisal score; this did not result in an interaction with framing. However, individuals with higher risk appraisals did expect a greater likelihood that an abnormality would be found if they screened ($r=.44$, $p<.001$) and were more likely to screen in order to make sure they were healthy ($r = .22$, $p<.001$).

For exploratory purposes, we examined whether frame and level of risk feedback influenced efficacy beliefs. As shown in Table 3, there were no main effects or interactions.

Correlates of screening intentions.

We predicted that higher self- and response-efficacy beliefs, construals, as well as risk appraisals, would correlate positively with screening intentions. Indeed, higher screening intentions were reported among participants with stronger self-efficacy beliefs ($r=.44$, $p<.0001$), response-efficacy beliefs ($r=.32$, $p<.001$) and higher risk appraisals ($r=.44$, $p<.001$) (Lipkus et al., 2018). With respect to construals, participants reported stronger screening intentions when the main reason for screening was to make sure they were healthy ($r=.42$,

$p<.001$) and when they expressed a greater likelihood that an abnormality would be found ($r=.19$, $p<.001$). In a follow-up multivariable regression model predicting screening intentions from the above variables ($F=72.1$, $\text{adj } R^2=.40$, $p<.0001$), greater reported screening intention was associated with higher self-efficacy beliefs ($\beta=.33$, $p<.001$), higher risk appraisals ($\beta=.62$, $p<.001$) and obtaining screening to make sure one is healthy ($\beta=.29$, $p<.001$).

CRC Screening outcomes.

Among the 400 participants at follow-up, 38 (9.5%, 6.8% with intent-to-treat) participants reported being screened. Most had a colonoscopy (50%) or a FOBT (32%). In 63% ($n=24$) of cases, the result was normal. Among the 362 who did not screen, 67 (18.6%) talked to a doctor within the last six months about screening; 18 (5%) made an appointment to undergo screening within the next 6 months.

Interaction of frame and risk feedback predicting screening.

We hypothesized higher screening rates among individuals informed of being at lower risk who received gain-frame information as well as those informed of being higher risk who received loss-frame information compared to the opposite pairings. This interaction was not supported using observed data ($OR=0.92$, 95% CI: 0.41 – 2.04) or in the intent-to-treat model ($OR=0.98$, 95% CI: 0.46 – 2.10).

Predictors of screening.

Table 4 presents the univariate results predicting screening based on observed cases and intent-to-treat analyses from baseline risk appraisals, efficacy beliefs, construals and screening intentions. Neither risk feedback nor the composite risk appraisal score predicted screening. We explored whether any specific risk appraisal measure predicted screening. Based on the observed data only, individuals who worried more about getting CRC in the next 10 years ($OR=1.43$, 95% CI: 1.01 – 2.03; $M=3.28$, $SD=1.28$ at baseline) and believed they would lower their chance of getting CRC if they screened within the next 6 months ($OR=1.24$, 95% CI: 1.02 – 1.51; $M=3.43$, $SD=1.86$ at baseline) were more likely to have screened. Based on the observed data only, individuals with higher response efficacy beliefs were more likely to have screened ($OR=1.43$, 95% CI: 1.02 – 1.99; $M=3.75$, $SD=1.92$ at baseline). Baseline intentions to screen was the strongest and most consistent predictor of screening (see bottom of Table 4; $M=4.96$, $SD=1.12$ at baseline).

Exploratory analyses of interactions predicting screening:

We explored whether risk appraisals, construals, and efficacy beliefs interacted with frame to predict screening. There were no significant interactions between message framing and risk appraisals or any efficacy beliefs. There was no interaction with the construal of finding a problem. There was an interaction with the construal to screen to make sure that one is healthy based on the observed data ($OR=0.58$, 95% CI: 0.34 – 0.99) and intent-to-treat analysis ($OR=0.58$, 95% CI: 0.36 – 0.95). Based on observed data, among individuals who received loss-frame information, a one-unit increase going from getting screened to find a problem to getting screened to make sure I am healthy increased the odds of being screened

by 1.56. Among participants who received gain-frame information, the opposite effect was found, decreasing the odds of being screening by 0.90. The same pattern held for the intent-to-treat analysis.

Exploratory analyses predicting talking to a doctor about screening and making a screening appointment.

We explored if the same correlates of screening were associated with talking with a doctor about and making an appointment to screen. None of these constructs predicted either of these two outcomes except for baseline screening intentions (see Table 4). Using the observed data and in the intent-to-treat analyses, participants who expressed stronger screening intentions were more likely to have talked to a doctor about screening and to have scheduled an appointment to screen.

Discussion

The extant literature shows that increasing risk appraisals motivates health behaviors, including CRC screening (Atkinson et al., 2016). A concern is that obtaining information that supports being at low risk could deter screening. One way of curbing this negative effect is to modify how people perceive CRC screening by matching level of risk estimates to gain- or loss-frame messages. To our knowledge, this is the first study to test experimentally the matching between tailored CRC risk feedback and message framing to influence screening intentions and CRC screening in a population of adults who never screened. We did not find the expected interaction for either outcome.

The lack of interaction between message framing with either risk feedback or risk appraisals was unexpected given prior correlational findings, at least using pre-existing risk perceptions (Apanovitch et al., 2003; Gallagher et al., 2011; Hull, 2012). Risk beliefs may shape people's perceptions and responses to framed health messages as long as risk beliefs are internalized. The latter is expected to occur when people provide their own personal ratings of risk and risk factors. In our study, people were given tailored risk feedback; however, they may not have had sufficient time to fully comprehend or internalize the risk information. Further, those who were at higher levels of risk may have instigated defensive reactions to deny the information (Lipkus et al., 2018). Overcoming defensive reactions is critical to the acceptance of risk feedback.

Among baseline constructs, intention to screen was a significant predictor of screening. Further, among those who did not screen, intentions predicted talking to a doctor about and making an appointment to screen. With respect to screening intentions, the strongest correlates were self-efficacy beliefs, risk appraisals, and the construal of getting screened to make sure one is healthy. With respect to risk appraisals, when we decomposed the 6-item risk appraisal variable into the cognitive and affective components, worry about getting CRC and feeling that one would get CRC if screening did not occur were significant univariate predictors of screening. This suggests that addressing feelings about risk is more potent than the cognitive dimension (e.g., absolute risk) in predicting screening.

Our exploratory findings did reveal an interaction between framing and the construal of screening as health-affirming. Individuals were more likely to screen if they read loss-frame information and would screen to affirm being healthy. While this finding requires replication, it suggests that construing a CRC screening test as a way to affirm one's health may mitigate fears or anxieties that may have resulted from receipt of loss-framed messages. Indeed, fear-inducing messages are effective in motivating health behavior primarily when people are provided ways to alleviate the fear (e.g., increase their sense of efficacy, Witte, 1994). In this study, reconstruing CRC screening as a way to affirm one's health rather than to detect a life-threatening problem may have reduced any fear among those who received loss-framed information and led to a higher likelihood of screening.

Despite the lack of support for our predicted main effects and interactions, screening rates improved. Participants began with no history of screening; yet 9.5% reported screening at follow-up. Among those who did not screen, 5% made an appointment to screen. Assuming all these participants did screen, this would translate to about a 14% screening rate – or about 12% using a more conservative intent-to-treat analysis. While these rates appear low, these simple online interventions on a population level are low-cost and have potentially high reach, and can motivate screening among adults who have never screened. Admittedly, other modalities, such as physician recommendation to screen (Hudson, Ferrante, Ohman-Strickland et al., 2012), provision of testing kits, written reminders, and telephone contacts with an advisor (see Rat, Latour, Rousseau, Gaultier et al., 2018, for review) have achieved higher screening rates. However, such methods are often more costly, and physicians are not always adherent to screening recommendations especially among patients with chronic disease, the uninsured, lower SES, lower education levels, and patients who have refused in the past (Hudson, Ferrante, Ohman-Strickland et al., 2012).

Our findings have implications for patient-provider communications about CRC screening. Screening was predicted by greater intentions to screen, which itself was correlated with greater self- and response-efficacy beliefs and by holding a belief that screening could affirm one's health rather than identify a health problem. These findings suggest that one avenue for improving communications about CRC screening could be to have health providers emphasize, especially among patients with high levels of worry and few risk factors, that getting screened may help reduce worry about CRC by affirming one's healthy status. Further, providers should emphasize the effectiveness of the various screening modalities to increase response efficacy beliefs as well as enhance self-efficacy beliefs by, for example, addressing potential barriers that limit a patient's ability to screen.

There are several study limitations. Participants were from a panel created to be representative of adults in the U.S.; how their reactions compare to representative samples of adults who do not engage in online studies is unknown. Further, the manipulation was not inclusive of a no risk feedback / no framing arm. We did not objectively verify screening nor did we ask why participants screened. The latter would have provided insights about possible mechanisms of actions resulting from our interventions. Our study did not include other potentially important variables that alone or in combination with other variables might influence screening intentions, such as health literacy.

In summary, study findings show that among adults who have never screened, the provision of CRC comparative risk feedback with framing do not individually or jointly predict screening. Nonetheless, we observed improvements in screening rates, although the precise mechanisms remain unknown. Promising constructs to focus on include the feeling components of risk (e.g., worry) and intentions, the latter of which correlates with self- and response-efficacy beliefs, higher risk appraisals, and construals. Future studies should include appropriate control groups and explore manipulating both framing and construals to influence screening.

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Table 1:**Examples of Gain- and Loss-Framed Messages**

Gain-Frame	Loss Frame
People who get screened regularly are doing all they can to protect their health. Thus, they will not regret their choice of having been screened if colorectal cancer is found earlier when more treatment options are available.	People who do not get screened regularly are not doing all they can to protect their health. Thus, they may regret their choice not getting screened if cancer is found when fewer treatment options are available.
People who follow a plan that includes regular colorectal cancer screening increase their chances of surviving colorectal cancer.	People who do not follow a plan that includes regular colorectal cancer screening increase their chances of dying from colorectal cancer.
You gain peace of mind knowing you are doing your best to protect the health of your colon.	You lose peace of mind knowing you are not doing your best to protect the health of your colon.
People who get screened for colorectal cancer can serve as a role model for their families and friends to get screened; and, as a result, perhaps helping to improve the health care of others.	People who do not get screened for colorectal cancer cannot serve as a role model for their families and friends to get screened; and, as a result, perhaps not helping to improve the health care of others.
When you get recommended colorectal cancer screening, you are doing your best to find colorectal cancer early. Detecting colorectal cancer early can save your life.	When you do not get recommended colorectal cancer screening, you are not doing your best to find colorectal cancer early. Failing to detect colorectal cancer early can cost your life.

Note: These statements appeared at the end of the informational materials on CRC screening.

Table 2:

Demographic centeracteristics of the Participants at Baseline and Follow-up

Variable	Baseline (N=560)		Follow-up (N=400)	
	<i>n</i>	Mean (<i>SD</i>) or Percent	<i>n</i>	Mean (<i>SD</i>) or Percent
Gender (Male)	262	46.8%	195	48.7%
Age	560	57.9 (6.2)	400	57.6 (6.6)
Race				
White, non-Hispanic	430	76.8%	314	78.5%
Black, non-Hispanic	41	7.3%	25	6.2%
Other, non-Hispanic	19	3.4%	14	3.5%
Hispanic	53	9.5%	34	8.5%
2+ Races, non-Hispanic	17	3.0%	13	3.2%
Education				
Less than high school	55	9.8%	30	7.5%
High school	203	36.2%	147	36.8%
Some college	159	28.4%	119	29.8%
Bachelor's degree or higher	143	25.5%	104	26.0%
Has health insurance	478	85.4%	342	85.5%
Married	326	58.2%	232	58.0%
Job Status				
Work fulltime	262	46.9%	193	48.4%
Work part-time	68	12.2%	37	9.27%
Unemployed	74	13.2%	57	13.03%
Retired	155	27.7%	117	29.32%

Note. Numbers have been rounded.

Interaction of Framing and Level of Tailored Risk Feedback on Screening Intentions and Study Mediators

Table 3:

Outcome	Gain Frame			Loss-Frame			p <		
	Above average risk (n=161)	Average risk (n=20)	Below average risk (n=98)	Above average risk (n=147)	Average risk (n=17)	Below average risk (n=117)	Mean effect for frame	Main effect for risk level	Interaction of frame by risk level
Baseline screening intentions	3.75 (0.17)	3.81 (0.43)	3.62 (0.21)	3.91 (0.17)	4.16 (0.52)	3.86 (0.18)	.50	.85	.83
Construal: Main reason for getting screened (1= To find my health problems to 7= To make sure that I am healthy)	4.86 (0.16)	4.83 (0.45)	5.08 (0.20)	5.13 (0.16)	5.14 (0.42)	5.33 (0.17)	.57	.41	.94
Construal: If you get screened for colorectal cancer, how likely is it that a problem will be found? (1=Extremely unlikely to 7=Extremely likely).	3.46 (0.13)	3.16 (0.34)	3.09 (0.18)	3.28 (0.14)	3.83 (0.53)	2.93 (0.17)	.83	.12	.92
Self-efficacy beliefs	4.64 (0.15)	5.11 (0.39)	4.72 (0.20)	4.68 (0.15)	5.35 (0.62)	4.56 (.19)	.58	.65	.57
Response efficacy beliefs	4.83 (0.11)	4.89 (0.27)	5.14 (0.11)	4.97 (0.09)	5.13 (0.30)	4.95 (0.13)	.22	.93	.15

Note. Numbers, which are rounded, represent means and standard error of the mean. Higher scores represent greater self- and efficacy beliefs and intentions.

Table 4:

Baseline Risk variable, Construal Beliefs, Efficacy Beliefs and Screening Intentions Predicting Follow-up Colorectal Cancer Screening, Talking to a Doctor about Screening and Making an Appointment to be Screened.

Baseline Variable	Colorectal cancer screening		Talked to doctor about screening		Made appointment to be screened	
	Observed	Intent-to-treat	Observed	Intent-to-treat	Observed	Intent-to-treat
Computer tailored risk estimate	0.97 (0.77, 1.22)	0.89 (0.72, 1.11)	1.01 (0.82, 1.24)	0.95 (0.79, 1.15)	0.99 (0.68, 1.44)	0.92 (0.64, 1.32)
Composite 6-item perceived risk score	1.09 (0.78, 1.52)	1.04 (0.79, 1.39)	1.14 (0.78, 1.60)	1.09 (0.80, 1.49)	0.81 (0.44, 1.48)	0.79 (0.47, 1.33)
Likelihood that a problem would be found (construal belief)	1.04 (0.83, 1.31)	1.06 (0.86, 1.31)	0.929 (0.76, 1.14)	0.93 (0.78, 1.11)	0.82 (0.59, 1.15)	0.80 (0.59, 1.09)
Screen to find one is healthy or to detect a problem (construal belief)	1.26 (0.93, 1.69)	1.17 (0.88, 1.56)	1.06 (0.87, 1.29)	1.00 (0.81, 1.23)	1.19 (0.81, 1.75)	1.17 (0.80, 1.71)
Self-efficacy belief	1.19 (0.97, 1.46)	1.18 (0.98, 1.42)	0.87 (0.72, 1.06)	0.91 (0.77, 1.08)	1.23 (0.91, 1.66)	1.22 (0.91, 1.62)
Response efficacy belief	1.43 (1.02, 1.99)	1.36 (0.98, 1.89)	1.18 (0.84, 1.65)	1.17 (0.92, 1.48)	0.92 (0.58, 1.46)	0.94 (0.67, 1.33)
Screening intention	1.52 (1.24, 1.86)	1.37 (1.14, 1.66)	1.43 (1.20, 1.70)	1.31 (1.13, 1.52)	2.05 (1.43, 2.93)	1.87 (1.34, 2.61)

Note. Numbers represent rounded odds ratios and 95% confidence intervals predicting having been screened, having talked to a doctor and having made an appointment. Analyses for the latter two outcomes are for participants who reported not having screened.

Statistically significant results are in bold.