

Article

Neuromarketing and Health Marketing Synergies: A Protection Motivation Theory Approach to Breast Cancer Screening Advertising

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Abstract

This study investigates the psychological and emotional mechanisms underlying women's reactions to breast cancer awareness advertisements through the dual lens of Protection Motivation Theory (PMT) and neuromarketing methods, addressing a gap in empirical research on the integration of biometric and cognitive approaches in health marketing. Utilizing a lab-based experiment with 78 women aged 40 and older, we integrated Facial Expression Analysis using Noldus FaceReader 9.0 with semi-structured post-exposure interviews. Six manipulated health messages were embedded within a 15 min audiovisual sequence, with each message displayed for 5 s. Quantitative analysis revealed that Ads 2 and 5 elicited the highest mean fear scores (0.45 and 0.42) and surprise scores (0.35 and 0.33), while Ad 4 generated the highest happiness score (0.31) linked to coping appraisal. Emotional expressions—including fear, sadness, surprise, and neutrality—were recorded in real time and analyzed quantitatively. The facial analysis data were triangulated with thematic insights from interviews, targeting perceptions of threat severity, vulnerability, response efficacy, and self-efficacy. The findings confirm that fear-based appeals are only effective when paired with actionable coping strategies, providing empirical support for PMT's dual-process model. By applying mixed-methods analysis to the evaluation of health messages, this study makes three contributions: (1) it extends PMT by validating the emotional–cognitive integration framework through biometric–qualitative convergence; (2) it offers practical sequencing principles for combining threat and coping cues; and (3) it proposes cross-modal methodology guidelines for future health campaigns.

Keywords: neuromarketing; Protection Motivation Theory; Facial Expression Analysis; health marketing; advertising



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1. Introduction

Breast cancer represents the most frequently diagnosed cancer and the leading cause of cancer-related deaths among women globally, accounting for nearly 30% of all new female cancer cases each year [1,2]. Screening methods such as mammography, clinical exams, and self-examinations are essential for early detection, with survival rates significantly increasing when diagnosis occurs during earlier stages [3]. Despite the availability of these preventive measures, adherence to screening guidelines remains inconsistent, particularly among women in their 40s and older. Public health campaigns have responded with emotionally evocative advertisements aimed at encouraging proactive screening behavior. However, research suggests that the mere presence of emotional appeal does not guarantee behavioral change.

While Protection Motivation Theory (PMT) has been widely applied to predict health-protective behaviors, existing studies in breast cancer communication often rely on self-reported measures alone and overlook the potential of neuromarketing tools to capture unconscious emotional processes. Few studies have systematically combined PMT's cognitive constructs with real-time biometric measures such as Facial Expression Analysis (FEA), creating a gap in both methodological integration and theoretical validation. Protection Motivation Theory (PMT), developed by Rogers [4], provides a comprehensive explanation for how individuals evaluate and respond to health threats. PMT distinguishes between two primary cognitive appraisals: threat appraisal (perceived severity and vulnerability) and coping appraisal (response efficacy and self-efficacy). The balance between perceived threat and perceived ability to respond effectively determines whether individuals will adopt adaptive behaviors [5].

Extensive research supports the use of PMT in health behavior change, including contexts such as HIV prevention [6], influenza vaccination [7], and cancer screening [8]. However, a critical limitation in prior research is the oversimplification of the link between observable emotional expressions and PMT's cognitive constructs. While emotions such as fear, happiness, or surprise can indicate arousal, cognitive appraisal involves higher-order processing influenced by individual, cultural, and contextual factors [9]. This study explicitly addresses this limitation by grounding the emotion–cognition mapping in empirical literature from emotional psychology and health behavior theory and by acknowledging its constraints in interpretation.

Neuromarketing techniques—such as eye-tracking, electroencephalogram, and FEA—have been increasingly applied in health communication research to gauge subconscious processing of stimuli [10,11]. FEA software like Noldus FaceReader [12] uses computer vision to quantify seven universal emotional states (happy, sad, scared, surprised, angry, disgusted, neutral), offering a dynamic lens through which to analyze public health messaging [13–15]. Despite these technological advancements, few breast cancer awareness studies have adopted a cross-modal design that integrates FEA with qualitative interviews, thereby enabling both implicit (biometric) and explicit (self-reported) data to be analyzed in tandem.

Accordingly, the present study addresses three operational research questions, as follows. (RQ1) Which facially expressed emotions dominate across breast cancer awareness ad types with varying emotional tone and content? (RQ2) How do these biometric emotional responses correspond to PMT's cognitive appraisal constructs? (RQ3) What evidence-based design principles can be derived for future awareness campaigns that balance emotional engagement with clear, actionable instructions? By focusing on a culturally specific sample of Greek women aged 40 and above, the study also examines the influence of socio-cultural context on message reception, while recognizing the limitations in generalizing beyond this population.

2. Literature Review

The Protection Motivation Theoretical Framework

Protection Motivation, developed by Rogers in 1975, represents a significant framework for understanding health-related behaviors, particularly in the context of interventions aimed at promoting protective health actions. PMT posits that individuals' motivation to engage in health-promoting behaviors arises from both threat appraisal and coping appraisal [16,17]. This theory's relevance has extended into various domains, especially in health marketing, where persuasion strategies are essential for influencing behavior change [18]. Although PMT has been widely validated, a gap remains in its experimental application with real-time biometric data to examine how threat and coping cues are processed emotionally and cognitively in tandem.

Compared with the Health Belief Model (HBM) [19], the Theory of Planned Behavior (TPB) [20], and the Transtheoretical Model (TTM) [21], PMT uniquely integrates affective and cognitive pathways, making it especially suitable for health messages that aim to elicit emotions while fostering actionable coping responses. Central to PMT is the recognition of how individuals appraise threats to their health, which encompasses perceived severity and perceived vulnerability. This framework asserts that, when a health threat is perceived as severe and likely to affect the individual, there is an increased motivation to engage in behaviors aimed at mitigating that threat [22]. For example, Rad et al. [23] demonstrated the effectiveness of PMT in predicting COVID-19 preventive behaviors in Iran, highlighting that individuals' threat perceptions influenced their protective actions during the pandemic. Such findings underscore the theory's utility in shaping public health strategies, as evidenced by its application in various studies focusing on protective behaviors, including skin cancer prevention among farmers [17] and health safety in emergencies [24,25]. Moreover, PMT is coupled with the concept of coping appraisal, which includes the perceived effectiveness of the protective behavior and confidence in one's ability to enact it (self-efficacy). Research indicates that enhancing self-efficacy can significantly impact individuals' engagement in protective health behaviors. For instance, Jeihooni et al. [26] found that self-efficacy was a critical determinant in predicting COVID-19 preventive behaviors among healthcare workers. This relationship suggests that interventions should not only convey health risks, but also empower individuals by enhancing their coping capacities [27]. As such, previous studies have shown PMT's adaptability across health contexts—from skin cancer prevention [24, 28], to COVID-19 protective behaviors—but these have primarily relied on self-report data, potentially limiting ecological validity when emotional reactions are rapid, unconscious, and subject to recall bias.

The current study builds on this literature by proposing that biometric indicators (e.g., FEA-coded fear or surprise) serve as proximal indicators of PMT's threat appraisal, whereas positive affective states such as happiness may signal coping appraisal. However, we also acknowledge that this relationship is not one-to-one: cognitive appraisal involves complex, higher-order processing influenced by memory, beliefs, and social norms [29]. Thus, in both our theoretical framing and our discussion, we treat biometric data as complementary—not equivalent—to cognitive constructs, positioning them as objective markers of emotional arousal rather than direct measures of appraisal.

Recent research demonstrates growing interest in integrating neuromarketing methods into health communication by understanding consumer psychology [30], as well as vaccination promotion [31–33] and anti-smoking campaigns [34,35].

These studies underscore the methodological and contextual innovations that our work adds: (1) a controlled comparison of six systematically manipulated breast cancer advertisements, (2) triangulation of implicit and explicit measures, and (3) a focus on message sequencing effects, where threat cues precede coping strategies.

3. Materials and Methods

3.1. Participants

Seventy-eight women aged 40 years and older were purposively recruited through local community health organizations and social media networks. Inclusion criteria included fluency in Greek, no current diagnosis of cognitive impairment, and no history of breast cancer. The sample size was determined based on previous FEA studies in neuromarketing with similar methodologies [29,30]. Demographically, participants ranged from 40 to 68 years old ($M = 52.4$, $SD = 6.1$), 62% held a university degree, and 48% reported a monthly household income above the national median. Such variables were recorded because age, education, and income have been shown to influence emotional processing

and health information uptake. Participants provided written informed consent in line with GDPR and national ethics protocols.

3.2. Experimental Setting and Stimuli

The experiment took place in the Integrated Marketing Communications Laboratory at the Department of Business Administration, National and Kapodistrian University of Athens (NKUA). Participants were seated individually in a sound-controlled room and viewed a 15 min media reel incorporating six digitally manipulated breast cancer awareness messages (Figure 1). Each ad was displayed for 5 s. The six ads were systematically varied along two dimensions: (a) emotional tone—fear-based (Ads 2, 5), hope-based (Ad 4), neutral/informational (Ads 1, 3, 6); and (b) message content—specific action cues (Ads 2, 4, 5) vs. general awareness (Ads 1, 3, 6). This design allowed us to isolate both emotional and cognitive appeal effects. Stimuli were developed in collaboration with health communication experts and approved by NKUA's Ethics Committee (ref: 236/2025).



Figure 1. Breast cancer awareness campaign posters presented to participants during the survey. (A) Poster emphasizing survival and optimism after treatment. (B) Poster highlighting the importance of regular screening and self-examination. (C) Poster providing breast cancer statistics and early detection facts. (D) Poster promoting prevention as the best therapy. (E) Poster with magnifying glass symbolizing screening and early diagnosis. (F) Poster encouraging empowerment through prevention and free mammography programs.

3.3. Facial Expression Analysis (FEA)

During exposure, participants' facial reactions were recorded using Noldus FaceReader 9.0, a widely validated FEA software program [36,37]. The system detects and classifies facial muscle movements into seven basic emotional expressions based on the Facial Action Coding System (FACS), as shown in Figure 2. Emotions were measured frame by frame (25 fps), producing a time-series dataset for each ad.

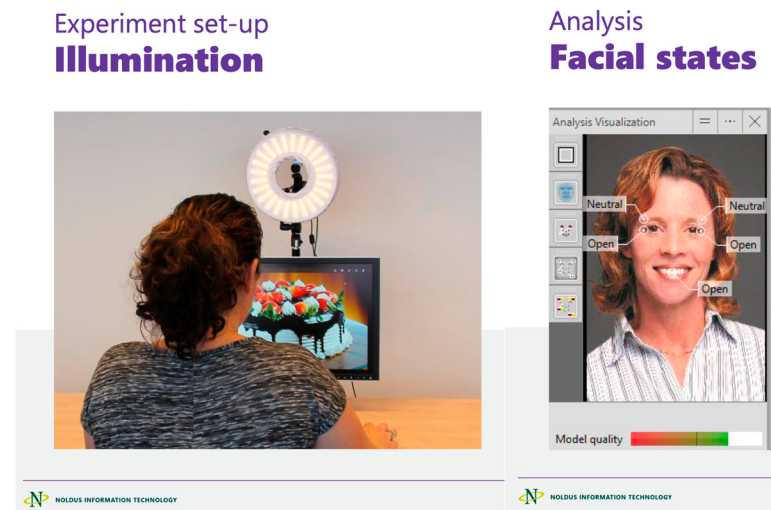


Figure 2. Noldus experimental set-up and facial analysis states. Source: Noldus FaceReader 9, Leanne W.S. Loijens, Ph.D., 8 July 2024.

3.4. Data Calibration and Processing

Raw video streams were batch-processed in three sequential steps adapted from Marques and Vilela [38]: (i) face detection (region of interest selection), (ii) face modeling (3D active appearance model fitting), and (iii) expression classification via deep neural network trained on >10,000 expert-coded frames. Expression intensity values ranged from 0 (undetected) to 1 (maximal) and could co-occur, because multiple action units are often active simultaneously.

3.4.1. Calibration

To minimize person-specific bias, FaceReader's automatic calibration selected the first frame with the lowest model error and subtracted its activation values from subsequent frames, following the procedure recommended by Wijk et al. [39].

3.4.2. Arousal Index

Moment-to-moment arousal was computed as the mean of the five most active action unit intensities after baseline correction. The 20 contributing AUs (e.g., AU 01 Inner Brow Raiser, AU 12 Lip Corner Puller) follow the schema in Ekman et al. [40]. Closed eye AU 43 is inverted so that larger values indicate low arousal.

3.4.3. Aggregation

For each advertisement we exported (a) the framewise emotion probabilities and (b) the arousal trace (25 fps).

3.5. Qualitative Interviews

Immediately following the experimental session, the sample of 78 participants was invited to participate in a brief private semi-structured interview. While qualitative studies often involve smaller samples, this research intentionally retained the full experimental

cohort in the interview phase to ensure complete cross-modal pairing of biometric and narrative data. This approach enabled robust within-subject comparison of implicit and explicit responses, aligning with the study’s triangulation design. Interviews lasted approximately 10 to 15 min and were conducted in a quiet room adjacent to the laboratory. To manage scheduling, three trained interviewers conducted sessions in parallel, ensuring that all interviews were completed within the same 2.5 h experimental block. The aim was to elicit interpretive insights into their emotional, cognitive, and behavioral reactions to the breast cancer awareness advertisements. Interviews focused on participants’ real-time emotional responses to each ad, their perceived severity and vulnerability to breast cancer, the perceived response efficacy of preventive behaviors of performing mammography, and their self-efficacy in engaging in such behaviors. These constructs were chosen to align directly with the PMT framework, which emphasizes the dual appraisal process (threat and coping) in motivating protective health actions [4].

Interviews lasted approximately 10 to 15 min and were conducted in a quiet room adjacent to the laboratory to ensure a controlled and comfortable setting. All interviews were audio-recorded with participant consent and later transcribed verbatim for analysis. The interview guide followed a flexible script that allowed probing and follow-up questions based on participant responses, thus maintaining consistency while enabling depth. Sample questions included: “How did this advertisement make you feel?”; “Did you feel personally at risk?”; and “Do you think you would act differently after seeing this message?”.

4. Results

This section presents the quantitative and qualitative findings from the multi-methods study combining biometric data from FaceReader analysis and semi-structured interviews. The goal was to assess emotional engagement, threat perception, and coping efficacy in response to six breast cancer awareness advertisements designed using PMT constructs.

4.1. Biometric Emotion Recognition Results

Participants’ facial expressions were analyzed using FaceReader software, which calculated mean emotion probabilities and arousal scores during the 5 s peak engagement window for each advertisement (Table 1). These values, ranging from 0 to 1, capture responses across seven primary affective states—happiness, sadness, fear, anger, disgust, surprise, and neutrality—as well as overall arousal intensity.

Table 1. Descriptive emotion probabilities and arousal scores per advertisement (n = 78).

Advertisement	Happiness	Sadness	Fear	Anger	Disgust	Surprise	Neutrality	Arousal
Ad 1	0.12	0.19	0.31	0.08	0.06	0.21	0.18	0.54
Ad 2	0.10	0.22	0.45	0.09	0.07	0.35	0.13	0.62
Ad 3	0.15	0.17	0.20	0.07	0.05	0.18	0.23	0.48
Ad 4	0.31	0.14	0.22	0.06	0.03	0.16	0.19	0.51
Ad 5	0.13	0.24	0.42	0.11	0.08	0.33	0.14	0.59
Ad 6	0.18	0.15	0.27	0.10	0.04	0.26	0.20	0.53

Note: Values represent mean emotion probabilities (range: 0–1) averaged over the 5 s peak engagement window.

Notably, Ad 2 and Ad 5 elicit the highest mean probabilities for fear (0.45 and 0.42, respectively) and surprise (0.35 and 0.33), suggesting successful activation of PMT’s threat appraisal mechanisms, particularly perceived severity and vulnerability. In contrast, Ad 4 generates the highest happiness score (0.31) and moderate arousal, indicating the presence of coping appraisal cues, such as self-efficacy and response efficacy.

These inter-advertisement differences in emotional responses support the theoretical premise that emotional cues influence cognitive appraisals and behavioral intentions. Table 1 offers a descriptive emotional profile for each advertisement and serves as the empirical foundation for subsequent inferential testing via repeated-measures ANOVA. Visual summaries are provided in Figure 3 (arousal index) and Figure 4 (emotion probabilities).

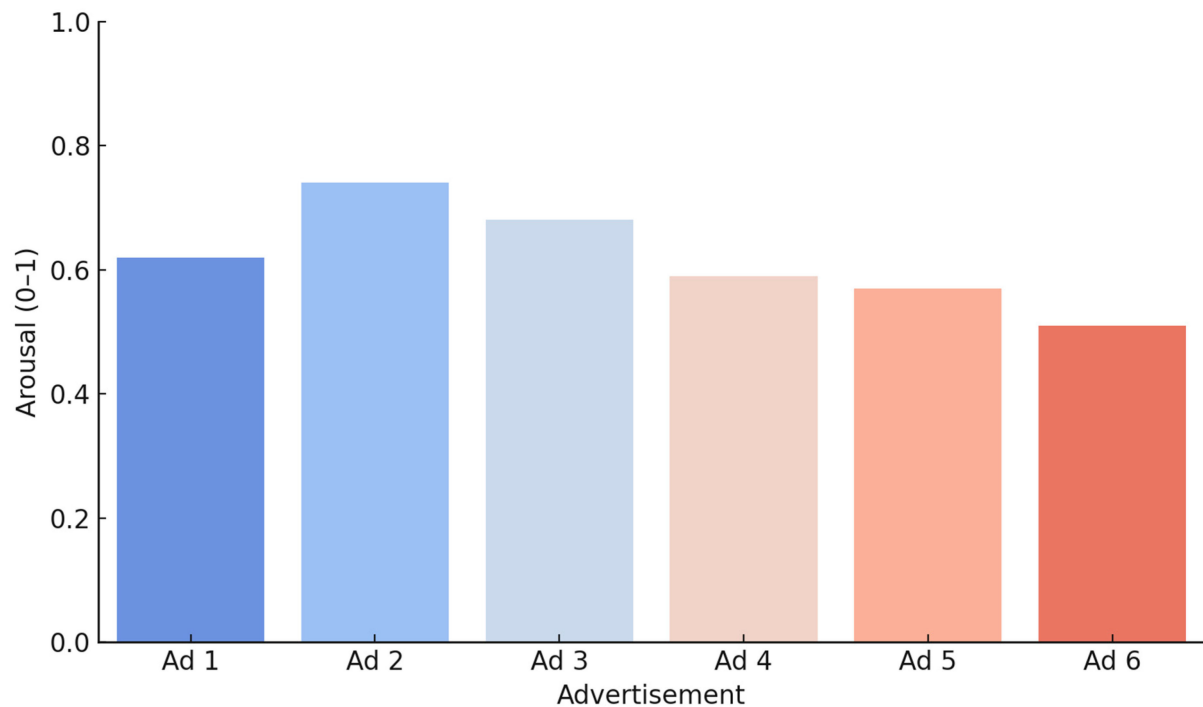


Figure 3. Mean arousal index per advertisement.

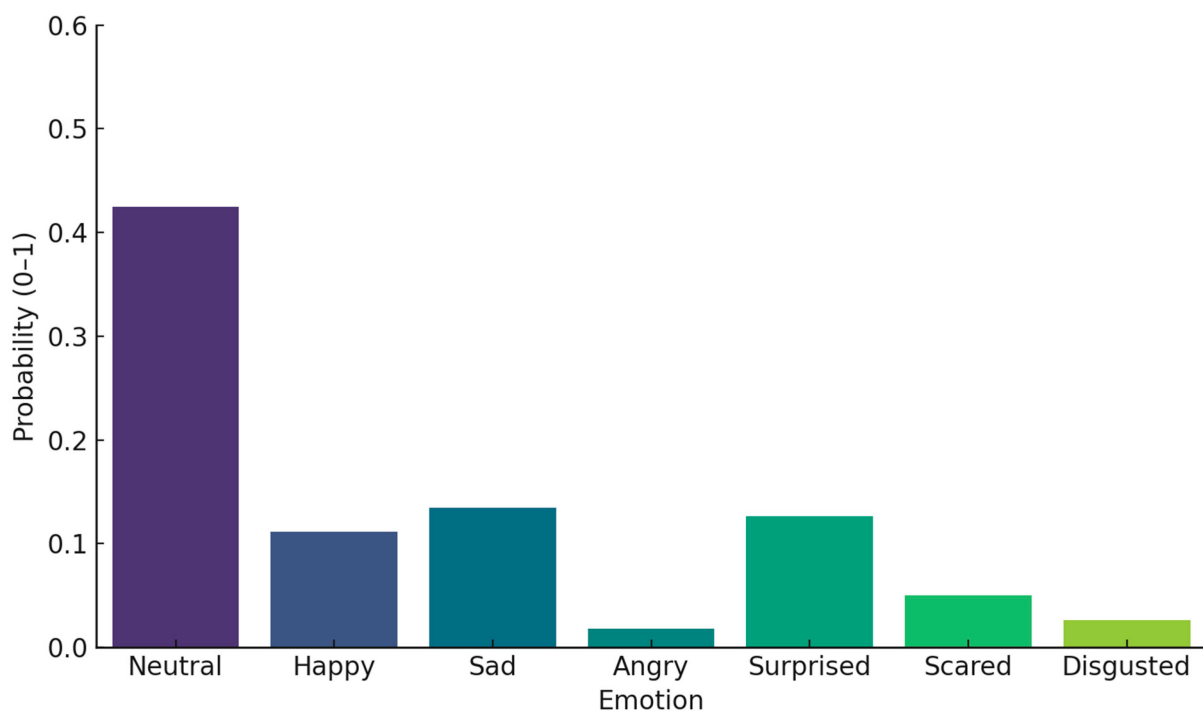


Figure 4. Average emotion probabilities across all advertisements.

Figure 3 illustrates the mean arousal index per advertisement. Ads 2 and 3 elicit the highest arousal levels, reflecting stronger emotional activation, while Ads 5 and 6 show comparatively lower arousal.

Figure 4 displays the average emotion probabilities across all six advertisements. Neutrality emerged as the dominant expression, followed by sadness and surprise, consistent with the serious tone of the campaign. Lower levels of anger and disgust suggest minimal emotional resistance or repulsion.

The statistical significance of emotional differences across advertisements was assessed using repeated-measures ANOVA, with the advertisement (Ad 1–6) as the within-subject factor and each emotion, along with arousal, as dependent variables. Analyses were conducted using IBM SPSS Statistics v29.0.2.0. When sphericity assumptions were violated, Greenhouse–Geisser corrections were applied [41]. Bonferroni-adjusted pairwise comparisons ($\alpha = 0.05$) were used to identify significant contrasts [42].

Table 2 presents the corrected F-values, degrees of freedom, significance levels, partial eta-squared (η^2p) values, and significant pairwise contrasts. Significant effects are observed for fear ($F(3.12, 145.2) = 12.67, p < 0.001, \eta^2p = 0.22$), surprise ($F(4.04, 188.1) = 10.32, p < 0.001, \eta^2p = 0.19$), happiness ($F(2.88, 134.5) = 7.41, p = 0.002, \eta^2p = 0.14$), and arousal ($F(3.42, 156.1) = 9.88, p < 0.001, \eta^2p = 0.18$). Based on conventional benchmarks—small ($\eta^2p \geq 0.01$), medium ($\eta^2p \geq 0.06$), and large ($\eta^2p \geq 0.14$)—the observed effects are large for fear and surprise and medium for happiness and arousal.

Table 2. Repeated-measures ANOVA results and post hoc comparisons for emotion responses across advertisements ($n = 78$).

Emotion	F (df)	p-Value	η^2p	Significant Post Hoc Contrasts (Bonferroni-Adjusted, $p < 0.05$)
Fear	$F(3.12, 145.2) = 12.67$	<0.001	0.22	Ad 2 > Ad 3, Ad 5 > Ad 1, Ad 5 > Ad 3
Surprise	$F(4.04, 188.1) = 10.32$	<0.001	0.19	Ad 2 > Ad 1, Ad 5 > Ad 3
Happiness	$F(2.88, 134.5) = 7.41$	0.002	0.14	Ad 4 > Ad 1, Ad 4 > Ad 2, Ad 4 > Ad 5
Sadness	$F(3.56, 164.4) = 2.47$	0.061	0.07	Not significant
Anger	$F(3.22, 148.3) = 1.98$	0.083	0.05	Not significant
Disgust	$F(3.01, 138.4) = 2.25$	0.078	0.06	Not significant
Neutrality	$F(2.93, 134.9) = 1.73$	0.114	0.04	Not significant
Arousal	$F(3.42, 156.1) = 9.88$	<0.001	0.18	Ad 2 > Ad 3, Ad 5 > Ad 1

These findings align with PMT’s conceptual assumptions. Fear and arousal are key indicators of threat appraisal (perceived severity and vulnerability), while happiness may reflect coping appraisal through heightened self-efficacy. Emotions such as sadness, anger, disgust, and neutrality show no statistically significant variation, indicating a more peripheral role in mediating protective intentions in this health communication context.

4.2. Thematic Coding and NVivo Analysis

To complement the biometric findings, qualitative interview transcripts were imported into NVivo 14 for thematic analysis. Employing both inductive and theory-driven approaches, 487 unique references are identified and categorized according to the four core constructs of PMT: Perceived Severity, Perceived Vulnerability, Response Efficacy, and Self-Efficacy. Additionally, emergent themes such as Message Credibility and Emotional Fit are also captured.

Intercoder reliability was assessed using Cohen’s κ , yielding a high agreement score of 0.87, indicating robust consistency across coders. This qualitative strand enriched the biometric analysis by capturing the cognitive and interpretive dimensions of audience response, thus offering a deeper understanding of how the advertisements influence both affective reactions and behavioral intentions.

Table 3 summarizes the thematic coding output with illustrative quotes.

Table 3. Thematic coding summary of interview transcripts based on PMT constructs (NVivo 14 analysis).

PMT Construct	Theme Description	Coded References (n = 487)	Example Quote
Perceived Severity	Emotional response to consequences of inaction	138	"That could be me if I keep postponing the test." (P14)
Perceived Vulnerability	Recognition of personal health risk	76	"It made me realize I'm not invincible." (P9)
Response Efficacy	Belief that the suggested behavior is effective	92	"They showed that early screening works." (P6)
Self-Efficacy	Confidence in one's ability to take preventive action	84	"I can do this—it's not that hard to book a test." (P3)
Message Credibility and Emotional Fit	Perception of realism and emotional balance of message	97	"I need both emotion and facts to trust the message." (P21)

Notes: Total references coded: 487, intercoder reliability (Cohen's κ): 0.87.

4.3. Protection Motivation Theory: A Thematic Analysis

Figure 5 presents a visual mapping of the PMT constructs as derived from NVivo-coded transcripts. Each of the four main PMT dimensions is supported by subordinate codes and representative participant narratives, providing a structured conceptualization of the data.

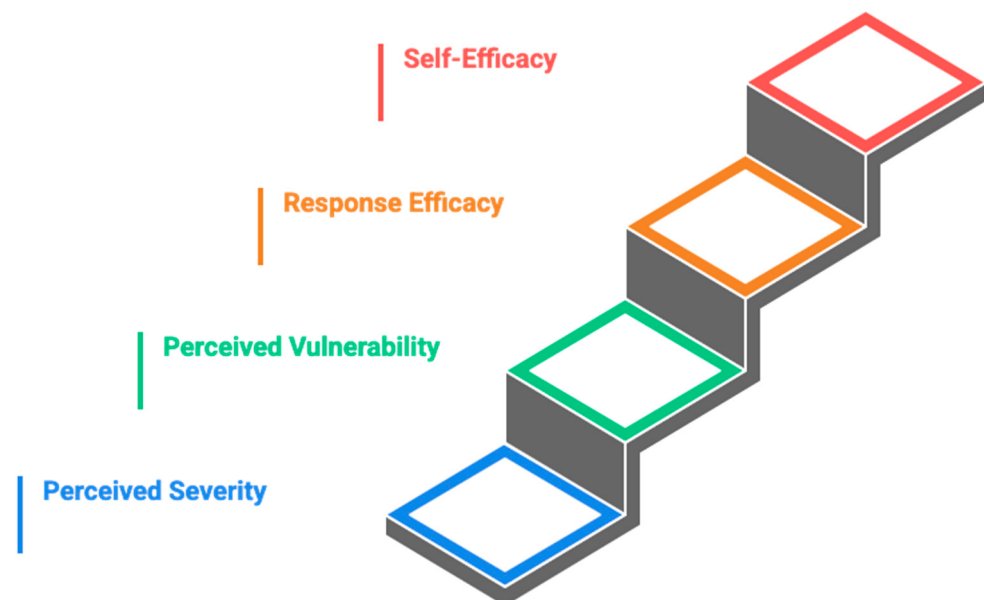


Figure 5. Thematic analysis of interview transcripts based on PMT constructs. Note: The figure presents color-coded themes—Perceived Severity (blue), Perceived Vulnerability (green), Response Efficacy (orange), and Self-Efficacy (red)—along with relevant sub-codes and exemplar quotes.

4.4. Expanded PMT Constructs and Subcodes

4.4.1. Perceived Severity (Blue)

Participants recognized the gravity of breast cancer consequences.

Health Consequences: "If I get seriously ill, it will affect my ability to work and take care of my family."

Social Impact: "I worry about being stigmatized if people find out I have this condition."

Economic Burden: "The cost of treatment and potential loss of income would be a huge burden."

4.4.2. Perceived Vulnerability (Green)

Self-assessments of risk featured prominently.

Personal Risk Assessment: "I know I'm at higher risk because of my family history."

Comparative Risk: "I see others getting sick, so I know it can happen to anyone."

Environmental Factors: "Living in a densely populated area increases my chances of exposure."

4.4.3. Response Efficacy (Orange)

Confidence in the effectiveness of early detection was high.

Effectiveness of Actions: “If I follow the guidelines, I can reduce my risk.”

Scientific Evidence: “The research shows these measures are effective.”

Practicality of Measures: “They’re easy to follow, not hard to do.”

4.4.4. Self-Efficacy (Red)

Participants expressed confidence in their ability to take action.

Ability to Perform Actions: “I have the discipline and resources.”

Overcoming Barriers: “I can overcome any challenges that arise.”

Maintaining Behavior: “I can sustain these behaviors long term.”

This expanded framework validates PMT’s utility in health communication, demonstrating how both emotional arousal (from biometric data) and cognitive appraisals (from interview content) shape behavioral intentions.

4.5. Cross-Modal Convergence: Biometric vs. Interview Data

To evaluate emotional dominance across modalities, a comparative matrix is developed to synthesize biometric emotion recognition data (FaceReader) and thematically code participant responses. Table 4 presents the cross-modal alignment for each of the six advertisements.

Table 4. Cross-modal dominance of emotional responses: interview coding vs. FaceReader output.

Emotion	Ad 1 (B/I)	Ad 2 (B/I)	Ad 3 (B/I)	Ad 4 (B/I)	Ad 5 (B/I)	Ad 6 (B/I)
Neutral	✓/✓	✓/✓	✓/✓	✓/✓	✓/✓	✓/✓
Happy	✓/✓	✓/	✓/			
Sad	✓/✓					
Angry						
Surprised	✓/	✓/	✓/			
Scared		✓/✓		✓/	✓/	
Disgusted						✓/✓

Note: “✓” indicates dominance of an emotion as detected either by biometric analysis (B) or interview narratives (I) for a specific advertisement.

The cross-modal comparison presented in the integrated table reveals two key patterns: (a) convergence, as Ads 2 and 5 exhibit strong alignment between facial expression data and participant narratives for fear and sadness, reinforcing the threat appraisal dimension of PMT, and Ad 4 shows consistent dominance of happiness, indicative of coping appraisal; and (b) divergence between facial expression data and participant narratives, such as for surprise, which was detected biometrically in Ads 1–3 but was not spontaneously reported in interviews. This suggests that certain emotional responses operate below conscious awareness, potentially influencing attention and message recall without explicit recognition. Conversely, disgust in Ad 6 was both facially detected and verbally reported, indicating a strong, consciously acknowledged aversive reaction.

This triangulation affirms the value of combining implicit (biometric) and explicit (interview) data to comprehensively capture the emotional and cognitive pathways activated by health messages.

4.6. Thematic Interview Analysis: Key Insights

Further thematic clustering of participant narratives yielded three dominant themes consistent with PMT theory.

4.6.1. Perceived Severity and Vulnerability

Participants frequently expressed heightened threat awareness—especially in response to Ads 2 and 5.

“When I heard my friend saying she ignored the lump for a year, I froze. That could be me.” (P14)

“I’ve been putting it off for too long. I don’t want to end up like that.” (P9)

“The fear in her sight was real. It made me think about how fragile life is.” (P27)

4.6.2. Coping Appraisal and Self-Efficacy

Ad 4 was frequently cited for its clarity and accessibility.

“I didn’t know it was that easy to book an appointment. That ad gave me hope.” (P3)

“The ad saying ‘your power is prevention’ really helped. I felt reassured.” (P20)

“I could relate to her—it was a regular woman just performing chemotherapy.” (P6)

4.6.3. Message Credibility and Emotional Fit

Participants preferred emotionally balanced, fact-based messaging.

“I want facts, not just drama. The one with the doctor felt more real.” (P21)

“It’s okay to scare me, but at least show what I can do.” (P11)

“That feeling made me feel like watching a horror movie. I stopped watching.” (P28)

These themes are visually synthesized in Figure 6, illustrating how emotional engagement and cognitive appraisal intersect to motivate or inhibit protective health behavior.

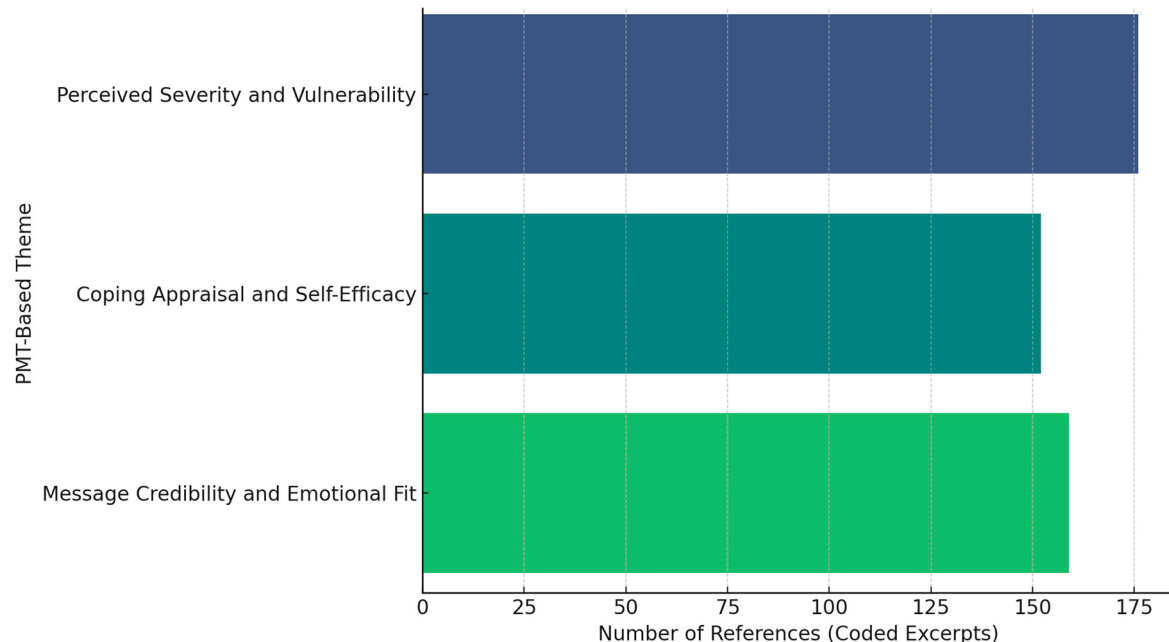


Figure 6. Frequency of coded themes from NVivo interview analysis.

5. Discussion and Conclusions

This study offers both theoretical and practical contributions by empirically validating the Protection Motivation Theory (PMT) through an innovative multimethod approach that integrates biometric data with qualitative thematic analysis. By aligning emotional

and cognitive responses to breast cancer awareness advertisements, the findings demonstrate how both threat appraisal and coping appraisal mechanisms shape health behavior intentions—the core pillars of PMT.

Within our experimental design, health marketing messages are deliberately framed to emphasize the severe consequences of untreated or late-stage breast cancer (i.e., high threat appraisal), while simultaneously presenting clear, actionable preventive behaviors, such as regular screenings and healthy lifestyle choices (i.e., coping appraisal). This dual-framing strategy is intended to instill urgency without inducing helplessness, fostering both concern and confidence in viewers' capacity to take protective action. Biometric data—captured using FaceReader software—confirmed heightened emotional engagement during these segments, while qualitative interviews reveal increased perceptions of self-efficacy, reflecting the successful operationalization of PMT constructs in a health marketing context.

Comparisons with prior research reveal alignment with Cismaru et al. [43] in showing that combined threat–coping framing maximizes persuasiveness, but our cross-modal evidence provides stronger empirical grounding for sequencing effects. Unlike earlier studies that relied solely on surveys, our multimethod design confirms that unconscious emotional cues can diverge from self-reported experiences, highlighting the value of integrating FEA into health communication research.

PMT is selected as the guiding theoretical framework due to its compatibility with the study's dual-method research design. On the biometric side, FaceReader enabled the detection of affective reactions—such as fear, surprise, and neutrality—which align with the threat appraisal component of PMT. On the qualitative side, thematic analysis of interview transcripts illuminate participants' beliefs concerning response efficacy, self-efficacy, and perceived costs, corresponding to the coping appraisal dimension.

This methodological complementarity underscores the cognitive-affective architecture of PMT by integrating objective physiological measures with subjective cognitive interpretations. Specifically, the study maps observed emotional responses (e.g., facially expressed fear or neutrality) to cognitive themes (e.g., self-efficacy, perceived vulnerability), thus offering a comprehensive understanding of how emotional arousal and message framing interact to motivate protective intentions. PMT serves as a theoretical bridge linking biometric indicators with motivational cognition, validating how the alignment of emotional engagement and cognitive processing enhances the persuasive power of health communication.

Ultimately, this study demonstrates how PMT can underpin emotionally intelligent, evidence-based health marketing campaigns. By connecting biometric indicators of emotional engagement with cognitive constructs of behavioral motivation, we propose a validated framework for designing public health interventions that are not only impactful, but also psychologically grounded.

5.1. Managerial Implications

From a managerial perspective, the findings offer valuable guidance for health communication professionals and campaign designers. The integration of PMT constructs—particularly perceived severity, vulnerability, and self-efficacy—into multimedia campaigns can significantly enhance audience engagement and behavioral intention. Practitioners should leverage emotion-laden content to stimulate threat appraisal while ensuring that coping strategies are framed as achievable, low-cost, and effective. The real-time biometric results demonstrated that segments emphasizing emotional threat—when followed by concrete, empowering advice—elicited the most sustained attention and positive affective responses. These insights can inform the production of targeted campaigns in both clinical

and public health contexts, ensuring that emotional triggers are balanced with actionable solutions to avoid message fatigue or defensive avoidance.

5.2. Social Implications

At a societal level, this study contributes to improving public health literacy and empowerment. The dual-method findings demonstrate that individuals not only respond emotionally to breast cancer threats, but also seek clarity and confidence in their ability to act. Effective communication strategies rooted in PMT can contribute to more informed, proactive communities—particularly among populations traditionally underserved in terms of access to screening and preventive care. By showcasing the behavioral and emotional impact of personalized messaging, this research advocates for inclusive, empathetic, and culturally sensitive health interventions that reduce fear while promoting agency.

5.3. Theoretical and Methodological Implications

Theoretically, this study contributes to the literature by demonstrating the operational fit of PMT with a multimethod research design. Unlike rational-intent models such as the Theory of Planned Behavior, PMT uniquely accounts for emotional arousal as a determinant of motivation. This makes it particularly relevant for health contexts where anxiety, fear, or urgency play central roles in behavior change. Methodologically, the study demonstrates how biometric tools like FaceReader can be combined with in-depth interviews to triangulate emotional and cognitive dimensions. This fusion enhances ecological validity and opens new avenues for behavioral research across diverse health domains.

5.4. Limitations and Future Research

We acknowledge several limitations: (a) the sample comprised only Greek women, introducing potential cultural bias; (b) the 5 s ad exposure may not fully replicate naturalistic viewing; (c) FEA technology cannot capture complex or mixed emotions; and (d) interviews were conducted immediately post-exposure, potentially amplifying recency effects. Future research should include cross-cultural samples, test varied exposure durations, and integrate longitudinal measures to examine behavioral follow-through.

5.5. Conclusions

This study expands PMT's application boundary by demonstrating that biometric data can complement, but not replace, cognitive measures in mapping the dual appraisal process. By systematically comparing FEA and interview findings, we identify three message design principles: (1) pair fear-inducing content with achievable coping strategies to prevent defensive avoidance; (2) use positive efficacy cues after threat cues to sustain engagement; and (3) balance emotional tone to maintain message credibility. This study contributes to the evolving field of health marketing by deepening our understanding of how emotional and cognitive mechanisms interact in shaping individuals' responses to health messages. Through a novel integration of biometric emotion recognition and qualitative thematic analysis—grounded in Protection Motivation Theory (PMT)—we offer both theoretical validation and methodological advancement. Our findings underscore that health communication is most effective when it engages the audience on both emotional and cognitive levels, activating mechanisms of threat appraisal (e.g., fear, vulnerability) and coping appraisal (e.g., self-efficacy, response efficacy).

The use of real-time biometric analytics, such as facial expression tracking through FaceReader, coupled with in-depth narrative coding via NVivo presents a multimethod framework capable of capturing the full spectrum of audience reactions. This approach not only affirms PMT's relevance in the context of emotionally charged health campaigns, but also establishes a replicable and scalable methodological blueprint for future research.

Such a framework enables researchers and practitioners to assess not only what messages are effective, but why and how they succeed in shaping behavioral intention.

Importantly, the implications of this work extend beyond breast cancer awareness to a wide range of public health challenges—including vaccination uptake, mental health stigma reduction, chronic disease prevention, and reproductive health advocacy. Future studies may explore the role of message framing (e.g., gain vs. loss), cultural and demographic moderators, or digital channel specificity (e.g., social media, mobile health apps). Moreover, integrating this approach with AI-driven personalization, longitudinal behavioral monitoring, or adaptive mHealth tools could lead to more nuanced, real-time health interventions tailored to individual psychological profiles.

Ultimately, this research demonstrates that the convergence of biometric feedback with behavioral theory opens promising pathways for designing emotionally intelligent, psychologically grounded, and data-driven health communication strategies. By synchronizing affective engagement with cognitive motivation, campaigns can activate both the heart and the mind—essential components for sustained behavior change. In doing so, we reinforce the strategic utility of PMT not only as a theoretical model, but as a practical tool for building impactful, evidence-based public health interventions capable of fostering meaningful societal outcomes.

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Abbreviations

The following abbreviations are used in this manuscript:

PMT	Protection Motivation Theory
FEA	Facial Expression Analysis
HBM	Health Belief Model

TPB	Theory of Planned Behavior
TTM	Transtheoretical Model
GDPR	General Data Protection Regulation
FACS	Facial Action Coding System

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