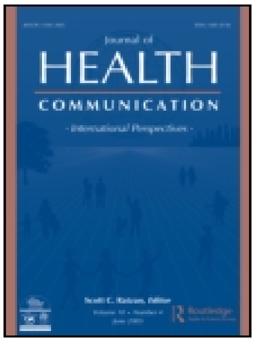

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Perceived Visual Informativeness (PVI): Construct and Scale Development to Assess Visual Information in Printed Materials

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There is a paucity of research on the visual images used in health communication messages and campaign materials. Even though many studies suggest further investigation of these visual messages and their features, few studies provide specific constructs or assessment tools for evaluating the characteristics of visual messages in health communication contexts. The authors conducted 2 studies to validate a measure of perceived visual informativeness (PVI), a message construct assessing visual messages presenting statistical or indexical information. In Study 1, a 7-item scale was created that demonstrated good internal reliability ($\alpha = .91$), as well as convergent and divergent validity with related message constructs such as perceived message quality, perceived informativeness, and perceived attractiveness. PVI also converged with a preference for visual learning but was unrelated to a person's actual vision ability. In addition, PVI exhibited concurrent validity with a number of important constructs including perceived message effectiveness, decisional satisfaction, and three key public health theory behavior predictors: perceived benefits, perceived barriers, and self-efficacy. Study 2 provided more evidence that PVI is an internally reliable measure and demonstrates that PVI is a modifiable message feature that can be tested in future experimental work. PVI provides an initial step to assist in the evaluation and testing of visual messages in campaign and intervention materials promoting informed decision making and behavior change.

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Visual messages—images used to convey ideas, emotions, or meaning through optical stimulation—often appear in health communication campaigns and interventions in or on pamphlets, billboards, and television public service announcements.[1] Even though a variety of visual messages assist in promoting health and communicating risk, there are few tools available to assess audience response to images. The National Cancer Institute (2002, 2007) provided how-to books for creating health communication materials, but only general, vague recommendations about selecting images. Similarly, Buki, Salazar, and Pitton (2009) provided a checklist to ensure the production of high-quality printed materials and encouraged the use of "simple, eye-catching, and culturally meaningful pictures and illustrations" (p. 566), but the authors did not provide suggestions on how to select such visual messages. Research suggests visual message features are important when considering diverse audiences (e.g., Resnicow et al., 2009; Springston & Champion, 2004), but there are few tools to assess audience evaluation of visual messages in health communication materials.

The current project uses two studies to develop and provide preliminary validation evidence for a measurement tool specifically designed to assess visual messages that convey statistical or indexical information. Perceived visual informativeness (PVI) is a construct that complements existing research on images in health communication, and attempts to push research in the area toward a more theoretical understanding of particular types of visual messages, specifically graphical representations of data and images that serve as visual (statistical) information, or pictures and images that convey proof of existence for some scenario or object (indexical information).

Visual Messages in Health Communication Research

There has been extensive research on visual message types in printed and multimedia health communication contexts, which provides suggestions as to why and how visuals are used, as well as some information about the effects of specific types of visual messages (e.g., photographs, illustrations, intense imagery). In addition, some authors have examined the function of specific stylistic features of visual presentations (e.g., Ancker, Senathirajah, Kukafka, & Starren, 2006; Peracchio & Meyers-Levy, 2005). Visual message components or features are also an important area of study in examining television video content (see Lang, Zhou, Schwartz, Bolls, & Potter, 2000; Morgan, Palmgreen, Stephenson, Hoyle, & Lorch, 2003; Niederdeppe, 2005). Regardless of medium, visual messages are frequently used in mediated health communication.

The Influence of Visual (Health) Messages

Research investigating the influence of visual messages usually manipulates the absence and presence of imagery (e.g., Boer, Ter Huurne, & Taal, 2006;

[1]Such visual messages may be presented as some graphical representation of data, photographs, and illustrations that depicts information about an experience, person, or object, intense or vivid imagery that evokes emotion, as well as juxtapositions or visual metaphors that attempt to convey complex information or relations more abstractly to further engage message processing and elaboration. The purpose of these visual messages might be to inform or educate audiences about certain health topics, enhance decision-making quality, attract and increase attention to an ad or pamphlet, or serve more generally as a persuasive tool to promote behavior change. For example, researchers might use charts, graphs, or other types of visual representations of data to assist patients' understanding of success rates and risks related to certain treatment options (e.g., Fagerlin, Wang, & Ubel, 2005). Similarly, an intervention could use certain graphics to enhance perceived relevance among people receiving a tailored pamphlet, which in turn could result in behavior change. Numerous studies support the role of images in the success of health communication, usually through outcomes related to attention, comprehension, recall, and adherence (for a review, see Houts, Doak, Doak, & Loscalzo, 2006).

Stephenson & Witte, 1998) or graphs (e.g., Parrott, Silk, Dorgan, Condit, & Harris, 2005), while fewer studies examine differential effects of images with distinct qualities (e.g., graph type; Hawley et al., 2008) or features (e.g., photographic perspective; Peracchio & Meyers-Levy, 2005). Reviewing decades of research on images in health communication, Houts, Doak, Doak, and Loscalzo (2006) found that, in general, images positively influence important behavioral antecedents such as attention, comprehension, and recall, and can influence behavioral change or adaptation. Although there is consensus that images are important to consider when developing health messages and materials, the informativeness and persuasiveness of these visual messages in such contexts is still relatively understudied. Because there are a vast number of visual message types in different communication channels—such as audiovisual public service announcements, social marketing campaign ads, and public health information pamphlets—research on visual messages lacks cohesion and a theoretical foundation of its own.

Confusion about the usefulness of visual messages and features to enhance health communication materials is likely due to the disparate nature of extant research, as well as to consistently mixed research findings. For example, Stephenson and Witte (1998) found intense images did not enhance the persuasiveness of text-based messages related to skin cancer. In contrast, another study found intense imagery facilitated increased message processing about warnings conveyed in television spots (Slater, Karan, Rouner, & Walters, 2002). Parrott and colleagues (2006) found that people presented with graphs communicating statistical evidence reported lower levels of comprehension and perceived the evidence in the visuals to be lower quality and less persuasive than the same information presented as text only. Other studies of graphs communicating risk and statistical information found that people viewing graphs were more likely to comprehend such evidence through the use of particular graph types (for an overview, see Ancker et al., 2006).

The most comprehensive review of visual messages in health communication provides evidence that images that are not statistically based do convey information/evidence and increase comprehension among patients, especially those with low levels of health literacy and numeracy (Houts et al., 2006). Current best practices for using images in health information are to pretest images in context, make sure images and text complement each other, ensure image simplicity, and attempt to select images that are culturally relevant and appropriate (Buki et al., 2009; Houts et al., 2006; National Cancer Institute, 2002, 2007). Within each of these recommendations, specific suggestions are not strongly supported empirically or theoretically.

A Common Conclusion

Even with inconsistent findings, studies and reviews examining the influence of visual messages on health communication regularly draw a common conclusion: more research needs to be done that moves beyond what one might call the *absence/presence paradigm*. An obvious next step in the study of visual messages is the identification of constructs and the validation of subsequent measurement tools that fit into existing theorizing while also contributing to new theorizing about health messages. The current body of research provides sufficient evidence to claim that, in theory and practice, visual messages should be a key consideration in public health communication and education. A hindrance to progress on research examining the visual component of health messages is a lack of constructs to study and use in theory building. PVI is a proposed construct that provides a beginning step for assessing the quality of visual messages attempting to communicate certain types of evidence.

PVI

PVI is a construct that should capture an individual's evaluation of the quality of visual evidence provided in an image. Wileman's (1993) visual design evaluation criteria have been suggested as one method of assessing visual images and information in health education materials (see Doak, Doak, & Root, 1996). Wileman suggested that images having the perceived quality of clarity tend to be easy to interpret and of high quality. This does not necessarily mean that clarity is synonymous with simplicity; complex graphical representations of data may efficiently and clearly communicate information, whereas overly simplistic graphical representations of data may obfuscate the same information. It is also important to consider persuasive and informative abilities of visual messages that do not contain numerical data. Messaris (1997) suggested indexicality as one potential mechanism through which visual images are persuasive. *Indexicality* refers to the ability of images to offer proof that some particular person, object, event, interaction, or behavior has existed or happened, currently exists or happens, or could exist or happen.[2] Images in printed health materials that include indexical data include sequences of images demonstrating how to perform medical self-exams; other indexical data is contained in images demonstrating different food serving sizes. Related to clarity and indexicality is the idea of image-text consistency. The goal of PVI is to assess evidence and information that clearly conveys a particular idea, thought, or set of data visually. Important in that conceptualization is the idea of visual and verbal message unity (Wileman, 1993), where both message modes attempt to communicate the same message.[3]

Chaffee (1991) argued that explication provides a framework for assessing the validity of a construct (i.e., how the construct should interact with other variables of interest) and that new measurement tools facilitated evaluation of that framework. A sound measurement tool should demonstrate internal reliability, as well as convergent, divergent, concurrent, and predictive validity (DeVellis, 2003). PVI is proposed as an umbrella measure of visual evidence quality in messages and materials, and as such should be related to, but distinctive from, other message constructs such as perceived attractiveness, perceived informativeness, and perceived message quality. PVI should also relate to, but be distinct from, individual preference for visual learning.[4]

There may or may not be a relation between a person's physical visual function (e.g., ability to see a pamphlet) and PVI, as visual function might affect how a person's ability to read text accompanying visual messages or view details within a particular image. Last, PVI should contribute to predicting perceived message effectiveness, which predicts actual message effectiveness (Dillard, Shen, & Vail, 2007). To determine whether PVI can concurrently influence other behavioral

[2]Indexicality in the traditional sense refers to photographic images that convey reality. We use the term here both to describe photographs that offer proof of something, as well as illustrations that are demonstrative of medical information such as tumor size and mole shape. This is a slight deviation from Messaris' (1997) theorizing on visual persuasion.

[3]For example, if there is an image juxtaposing a healthy lung and a cancer lung, the caption or text tied to that image should offer some explanation or message about that image. If the image and text are not unified in some way, the expectation with the PVI construct is that the visual message will be evaluated as less informative than if there was image-text consistency. The potential influence of captions and headings on the evaluation of risk judgments has also been posited (Lipkus, 2007), providing further rationale for the construct of PVI to consider image-text consistency. This idea of image-text consistency is in line with current theorizing on visual argumentation as well, which suggests that images and words are rarely independent of each other when attempting to convey a particular idea (see, e.g., Groarke, 2002).

[4]Individuals who prefer visual presentations of data, narratives, and information will likely prefer visual messages and could be biased toward believing more information is present. However, PVI should not simply be a proxy for visual learning preference as well-presented visual evidence or information should also be rated highly by those with verbal learning preferences.

antecedents, analyses also examine if the proposed construct predicts variance in decisional satisfaction and key constructs from the health belief model (see Champion & Skinner, 2008).[5]

Study 1

The first study aimed to create a scale to assess PVI and provide evidence for convergent, divergent, and concurrent validity. Study 1 took place within the context of a larger project that investigated the influence of different message strategies on promoting breast cancer screening. As such, some measures used in the study refer specifically to cancer screening, and all text and visual images related to breast cancer.

Method

Visual messages for Study 1 were taken primarily from an online archive maintained by the National Cancer Institute (2010), while some graphs, charts, and other pictures were recreated or taken from existing printed health communication materials related to breast cancer. Images conveyed statistical or indexical information/evidence,[6] and can be obtained from the first author.

Participants

We recruited 335 women who were 25 years of age or older ($M = 41.04$, $SD = 13.18$). Women were targeted exclusively because breast cancer affects a much larger number of women than men; most new breast cancer cases will occur in women (see Siegel, Ma, Zou, & Jemal, 2014). Of the participants, 20 (6%) had a history of breast cancer.

Procedure

Women participated in the study at a mall located in a suburban Midwestern area with population of slightly more than 100,000. A portable lab was set up at the main intersection of the mall, with 11 laptop computers and a color laser printer networked together by a 20-port switch. Mall representatives insisted members of the research team not solicit participation from patrons. Instead, six large signs providing university affiliation of the project, a brief description of the study, and a description of procedures and incentive were used to attract participants.

Women who agreed to participate completed a brief survey on a laptop that gathered information related to demographics and constructs of interest to the larger study. Participants were the given a pamphlet with information about breast cancer screening, which they were asked to examine for 5–10 minutes. There was a pool of 12 imagesused in the study; each participant viewed two images within her pamphlet. In total, there were six unique image combinations presented to participants, with each participants receiving one combination. Participants completed a second,

[5]Selection of the outcomes was predetermined because the present report was part of a larger study investigating the influence of different message strategies on promoting informed decision making and behavior change related to breast cancer screening.

[6]For example, a photograph of a woman having a mammogram was used in the current study. While that picture does not contain the visual presentation of statistics or evidence, it does present indexical information, both for women who have not yet had a mammogram and those who have, about that particular procedure. The photograph certainly does not provide the full experience, including any nervousness or discomfort, but it does convey information about what equipment is involved and the roles/activities of patients and providers.

longer survey after reading through the pamphlet. After completing the second survey, participants were debriefed and given US$15 compensation. All procedures were approved by a university institutional review board.

Measures

PVI. Eleven items were created for the PVI scale, based on research and theorizing outlined previously in this article. All original items, written at a seventh-grade level, are presented in Table 1. The final scale, which eliminated four items based on results from exploratory factor analysis, is described in greater detail in the Results section. Participants responded to each PVI item on a 5-point scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). The seven-item scale demonstrated good internal reliability (Cronbach's $\alpha = .91$), $M = 3.84$, $SD = 0.84$.

Table 1. Principal component analysis of perceived visual informativeness items

	Factors				
	I	II	*M*	*SD*	Corrected item-total correlation
Item 1: The images contained essential information.	.828		3.93	.996	.740
Item 2: The visual information in the pamphlet was clear.	.811		4.05	.909	.701
Item 3: The images made other ideas easier to understand.	.804		3.78	1.06	.795
Item 4: The images were large enough to see.	.747		3.93	1.05	.493
Item 5: I found the images in the pamphlet informative.	.739		3.64	1.11	.745
Item 6: Images in the pamphlet helped me understand the rest of the content.	.692		3.83	1.02	.711
Item 7: I think the images from the pamphlet are worth remembering.	.689		3.70	1.14	.760
Item 8: I spent more time looking at the pictures in the pamphlet than the text.		.841	2.25	1.17	.429
Item 9: If it weren't for the images, I would remember less of the pamphlet.		.726	2.82	1.28	.568
Item 10: The images in the pamphlet really shaped my thinking.		.674	2.99	1.17	.688
Item 11: I will remember more information from the images than the words.		.665	3.34	1.21	.612
Variance explained	53.923%	12.066%			
Eigenvalues	5.932	1.327			

Note. Principal components analysis using varimax rotation with Kaiser normalization. Only factor loadings above .5 displayed. The mean of Items 1 through 7 was used for correlation and regression analysis.

Additionally, for Study 2 wording of some items was shifted to reflect the nature of testing PVI on individual images as opposed to within the context of pamphlets. For Study 2, item wording was as follows for Items 1 through 7: "The image contains essential information." "The visual information in the image is clear." "The image makes other ideas easier to understand." "The image is large enough to see." "I find the image informative." "The image helped me understand the rest of the content." and "I think the image is worth remembering."

Perceived Message Quality (PMQ). Five items, adapted from Cacioppo, Petty, and Morris (1983), measured PMQ in the present study. Items were modified so they referred to the pamphlets rather than to individual messages. Participants responded on a 5-point scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*), $M = 4.15$, $SD = 0.80$. Example items include "This pamphlet was persuasive" and "I feel that the pamphlet made its point effectively." The PMQ scale was found to be internally reliable (Cronbach's $\alpha = .92$).

Perceived Informativeness. To measure perceived informativeness, we used two items, previously used by Cho and Boster (2008): "The pamphlet was informative" and "I learned something new from the pamphlet." Participants responded on a 5-point scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*), $M = 4.39$, $SD = 0.82$. The scale demonstrated good internal reliability, Cronbach's $\alpha = .85$.

Perceived Attractiveness. One item measured perceived attractiveness, which had been used in previous research on printed health communication materials (Bull, Holt, Kreuter, Clark, & Scharff, 2001). The one-item asked, "How attractive did you find the pamphlet?" with response options ranging from 1 (*not at all*) to 6 (*very much*), $M = 5.05$, $SD = 0.92$.

Perceived Effectiveness. To measure perceived effectiveness, we adapted three items from Fishbein, Hall-Jamieson, Zimmer, von Haeften, and Nabi (2002). The items included "Was the pamphlet convincing?" "Would the pamphlet be helpful in convincing your friends to be screened for breast cancer regularly?" and "Would people your age who have never been screened be more likely to get screened after reading the pamphlet?" Participants responded on a 4-point scale ranging from 1 (*definitely no*) to 4 (*definitely yes*), $M = 3.26$, $SD = 0.53$, and the scale exhibited good internal reliability, Cronbach's $\alpha = .85$.

Visual/Verbal Learning Preference. We used 11 items focusing on verbal-visual learning preference from the Felder and Silverman (1988) index of learning styles. Participants read the beginning of 11 statements and selected one of two options to complete each statement. Completion options were either focused on visual or verbal learning preferences (e.g., "I prefer to get new information in..." followed by the options "pictures, diagrams, graphs, or maps" and "written directions or verbal information"; Felder & Silverman, 1988). All responses indicating a verbal preference were dummy-coded as "1," with all visual preferences coded as "2." Participant responses were then summed to create an 11-point continuum of visual/verbal learning preference (score range = 11–22), with higher scores indicating a preference for visual learning, $M = 18.38$, $SD = 2.93$.

Visual Function. The Visual Function 14-item measure (VF-14; Steinberg et al., 1994), an established measure of visual ability, was adapted for this study. In its original form, high scores on the VF-14 indicate more vision problems, but we reverse-coded the scale so that high scores represented greater visual ability. Participants were presented with 14 items such as "Even with glasses, do you have difficulty reading a newspaper or book?" and responded on a 5-point scale ranging from 0 (*unable to do activity*) to 4 (*no*, meaning no difficulty). The mean of the 14 questions was taken and then multiplied by 25 (see Steinberg et al., 1994) to provide scores ranging from 0 to 100. A score of 0 indicates severely impaired visual ability, whereas a score of 100 represents high visual ability. The measure exhibited good internal reliability, Cronbach's $\alpha = .91$, $M = 91.89$, $SD = 12.74$.

Decisional Satisfaction. We used a single-item measure to assess the outcome of decisional satisfaction with breast cancer screening behavior. The item asked participants the question, "Based on the information you just received, are you more or less satisfied with your approach to screening?" Participants responded on a 3-point scale, with 1 representing *less*, 2 representing *the same as before*, and 3 representing *more* ($M = 2.47$, $SD = 0.61$).

Health Belief Model Constructs. We measured four health belief model constructs as outcome variables: perceived susceptibility, perceived benefits, perceived barriers, and breast cancer screening self-efficacy. Champion's (1999) measures of perceived susceptibility, perceived benefits, and perceived barriers were used for the present study, but item wording was adapted to represent breast cancer screening generally rather than mammography specifically. Self-efficacy was measured using a scale developed by Champion, Skinner, and Menon (2005).

All scales used for health belief model constructs used a 5-point scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). All health belief model measures met internal reliability standards: for perceived susceptibility, $M = 2.51$, $SD = 0.87$, Cronbach's $\alpha = .85$; for perceived benefits, $M = 4.29$, $SD = 0.79$, Cronbach's $\alpha = .89$; for perceived barriers, $M = 1.54$, $SD = 0.65$, Cronbach's $\alpha = .89$; and for self-efficacy, $M = 4.47$, $SD = 0.70$, Cronbach's $\alpha = .96$.

Demographics. All participants were women. Participants provided further information about their age, race/ethnicity, and education. The mean age of women was 41.04 years ($SD = 13.18$). Participants identified themselves as White (73.7%; $n = 247$), Black/African American (8.7%; $n = 29$), Asian/Pacific Islander (9.9%, $n = 33$), Hispanic/Latino (3.6%, $n = 12$), or other (3.6%; $n = 12$), and two participants failed to respond. Many women in the sample completed college and obtained an advanced degree (42.4%, $n = 142$), others responded that they had some college experience (17.3%, $n = 58$), had graduated high school (17.6%, $n = 59$), or had completed some high school (1.2%, $n = 4$). Seventy-two participants (21.5%) did not provide education data because of a random data collection error.[7] In addition, for data analysis purposes, participants were assigned a pamphlet code (ranging from 1 to 6) to identify which pair of images they received in their pamphlets.

Results

Principal Components Analysis

We used principal components analysis with varimax rotation to explore the measurement qualities of the 11 PVI items. The analysis revealed two factors with eigenvalues over one, predicting 54% and 12% of the variance, respectively. No items cross-loaded on the first and second factors using a cutoff of .50 (see Table 1).

The seven items comprising the first factor had strong face validity when considering the conceptual definition of PVI. The items all focused on one or more of the main theoretical concepts of clarity, indexicality, and image-text consistency. The four items making up the second factor seemed to stray from the conceptualization of PVI, as they focus on preference for visual information rather than assessment of visual messages. Those four items put verbal and visual messages more

[7]The research team programmed the computer survey interface used to collect data onsite incorrectly, so education data were not collected for a short time at the beginning of data collection. The sample size for the study was large enough that such an error should not bias any analysis.

in contest with one another rather than attempting to focus on assessing the visual messages and their interplay with verbal messages. Items loading on the second factor were dropped,[8] and a second principal components analysis was run on the seven items loading on the first factor to ensure factor replication (see Brown, 2006). The second analysis resulted in all seven items loading on one factor, explaining 65% of the variance, with an eigenvalue of 4.55 and no factor loadings less than .65. The seven items loading on the first factor proved to have good internal reliability (Cronbach's $\alpha = .92$).

Convergent and Divergent Validity

To explore relations between PVI and existing message constructs, we examined correlations between all message variables. Consistent with expectations, PVI was positively associated with PMQ ($r = .40$, $p < .001$), perceived informativeness ($r = .36$, $p < .001$), and perceived attractiveness ($r = .34$, $p < .001$). PVI was also positively associated with a preference for visual learning ($r = .23$, $p < .001$), but was not associated with visual function ($r = .05$, $p = .36$). Table 2 provides correlations between all study variables.

Concurrent Validity

The final sets of analyses performed using PVI from the initial study attempted to establish its concurrent validity, serving as a foundation for later investigation of predictive validity. PVI is conceptualized as a message construct that should be able to predict variance in relevant message outcomes. For the present study, the outcomes tested were perceived message effectiveness, which often predicts actual message effectiveness (Dillard et al., 2007), decisional satisfaction, and four key constructs from the health belief model: perceived susceptibility, perceived benefits, perceived barriers, and self-efficacy (see Champion et al., 2005). Decisional satisfaction and health belief model constructs all related specifically to breast cancer screening. Six hierarchical regression analyses were performed to determine whether PVI predicted unique variance above that predicted by demographics (entered in Block 1), visual preference and ability (entered in Block 2), pamphlet image combination (entered in Block 3), and message constructs (entered in Block 4). PVI was entered as the fifth and final regression block in analyses (see Tables 3 and 4). PVI was a significant predictor of perceived message effectiveness ($B = .15$, $p < .001$), decisional satisfaction related to breast cancer screening ($B = .14$, $p = .01$), perceived benefits ($B = .17$, $p = .003$), perceived barriers ($B = -.15$, $p = .005$), and mammogram self-efficacy, ($B = .12$, $p = .04$). PVI did not predict variance in perceived susceptibility. See Tables 3 and 4 for complete regression results.

[8]All other analyses in the present article are done with the seven-item PVI scale. To further ensure that the four items were not a better measure of PVI, all analyses presented were run with the four deleted items as an additional variable. The seven-item PVI scale was correlated with the mean of the deleted items ($r = .61$, $p = .009$). The four deleted items were also correlated with perceived message quality ($r = .14$, $p < .01$), perceived informativeness ($r = .13$, $p = .02$), perceived attractiveness ($r = .19$, $p = .001$), and perceived effectiveness ($r = .24$, $p < .001$), which is not surprising given the large correlation between the PVI seven-item scale and the mean of the four deleted items. The correlations between the four unused items and those constructs were all smaller than those found using the seven-item PVI scale. In addition, the four deleted items were more highly correlated with visual learning preference ($r = .38$, $p < .001$) than the seven-item PVI scale ($r = .23$, $p < .001$), consistent with the conclusion that the four deleted items measure something related to preference for visual messages rather than visual information/evidence quality. In addition, the deleted items were not a statistically significant predictor in any of the regression analyses, when entered with the PVI scale.

Table 2. Correlations between study variables

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. PVI	1.00	.396***	.358***	.341***	.417***	.228***	.051	.247***	.102†	.260***	−.163***	.161**	−.037	.024	−.165**
2. PMQ		1.00	.776***	.394***	.457***	−.074	.055	.163**	.042	.355***	−.211***	.263***	.115*	.119*	−.117†
3. PercInform			1.00	.323***	.365***	−.015	.071	.187**	−.034	.384***	−.183**	.169**	−.055	.150**	−.033
4. PercAttract				1.00	.452***	.049	.020	.222***	.034	.104†	−.050	.109*	.154**	.077	−.196**
5. PercEffect					1.00	.028	.114*	.246***	.156**	.206***	−.181**	.176**	.155**	.105†	−.184**
6. V-V LP						1.00	.063	.103†	.050	.003	−.037	−.062	−.114*	.034	.066
7. VisFunction							1.00	.096†	−.139**	.154**	−.337***	.162**	−.145**	.052	.144*
8. DecSat								1.00	−.018	.048	−.105†	.102†	−.027	.078	−.070
9. PercSusc									1.00	−.084	.061	−.046	.091†	.015	−.101
10. PercBene										1.00	−.312***	.352***	.009	−.009	.023
11. PercBarr											1.00	−.424***	−.096†	.075	−.037
12. SelfEff												1.00	.056	−.213***	.039
13. Age													1.00	−.212***	−.172**
14. Race														1.00	.142*
15. Education															1.00

Note. PVI = perceived visual informativeness; PMQ = perceived message quality; PercInform = perceived informativeness; PercAttrat = perceived attractiveness; PercEffect = perceived effectiveness; V-V LP = visual/verbal learning preference (lower scores indicate verbal preference, higher scores indicate visual preference); VisFunction = visual function measured by the VF-14 (Steinberg et al., 1994), where higher scores indicate more visual ability; DecSat = satisfaction with approach to decision making about breast cancer screening; PercSusc = perceived susceptibility; PercBene = perceived benefits; PercBarr = perceived barriers; SelfEff = self-efficacy.

†$p < .10$. *$p < .05$. **$p < .01$. ***$p < .001$.

Table 3. Hierarchical regression analyses predicting perceived effectiveness and cancer screening decision satisfaction

	Perceived effectiveness			Cancer screening decision satisfaction		
	B	*SE*	R^2	*B*	*SE*	R^2
1. Demographics			.052**			.009
Age	.005	.002*		.000	.003	
Race/ethnicity	.028	.028		.021	.040	
Education	−.039	.026		−.024	.037	
2. Visual variables			.110***			.032†
V-V LP	.005	.010		.009	.014	
VisFunction	.007	.002**		.005	.003	
3. Pamphlet	.003	.008	.121†	.003	.012	.034
4. Message variables			.272***			.064†
PMQ	.139	.059*		−.054	.082	
PercInform	.008	.055		.087	.076	
PercAttract	.112	.034**		.052	.047	
5. PVI	.149	.039***	.309***	.135	.055*	.087*
Constant	.710	.369†		1.005	.520†	
N		253			252	

Note. Coefficients (*B*) and standard errors (*SE*) are for the final model in which all variables are entered. The R^2 column represents the amount of variance explained by all of the blocks included up to that point. Subtracting R^2 from the previous block will yield R^2 change (i.e., the amount of variance explained by that block alone). PVI = perceived visual informativeness; PMQ = perceived message quality; PercInform = perceived informativeness; PercAttrat = perceived attractiveness; V-V LP = visual/verbal learning preference (lower scores indicate verbal preference, higher scores indicate visual preference); VisFunction = visual function measured by the VF-14 (Steinberg et al., 1994), where higher scores indicate more visual ability; Pamphlet = identification of which of six pairs of images women received.

†$p < .10$. *$p < .05$. **$p < .01$. ***$p < .001$.

Study 2

Study 1 offers evidence of face, convergent, divergent, and concurrent validity for PVI. Following the completion of the initial study, there were two remaining questions that needed to be answered:

1. Does PVI have predictive validity?
2. Is PVI modifiable?

The second question is important to answer, as knowing that will make it easier to answer the former through proper randomized experiments. If PVI can be manipulated by adding or taking away statistical or indexical information from a visual message, then it can be manipulated in future experiments to determine the construct's (potential) predictive validity. To test whether PVI is modifiable, a small-scale experiment was conducted.

The same 12 images ($k = 12$) used in Study 1 were used in Study 2. To test whether or not information could be removed from visual messages, the original study images were cropped to remove content from the image. For example, if a photograph featured a woman having a mammogram with a technician and medical equipment, the woman having the mammogram was removed from the photograph. If a graph or table was the image in question, text or visual information was removed. Given the aforementioned conceptualization of PVI, scores should be lower for participants who viewed images with parts of the image cropped out. In addition, images were classified as conveying either statistical ($k = 6$) or indexical

Table 4. Hierarchical regression analyses predicting four health belief model constructs

	Perceived susceptibility			Perceived benefits			Perceived barriers			Mammogram self-efficacy		
	B	*SE*	R^2	*B*	*SE*	R^2	*B*	*SE*	R^2	*B*	*SE*	R^2
1. Demographics			.019			.003			.020			.062**
Age	.005	.004		.002	.004		−.008	.003**		.000	.003	
Race/ethnicity	.075	.055		−.058	.004		.040	.037		−.188	.042***	
Education	−.056	.051		.065	.041		−.034	.034		.066	.039†	
2. Visual variables			.034			.029*			.136***			.101**
V-V LP	.017	.019		−.010	.015		.001	.013		−.022	.015	
VisFunction	−.008	.004†		.006	.004		−.015	.003***		.009	.003**	
3. Pamphlet	.017	.016	.038	−.026	.013	.032	.009	.011	.137	−.024	.013†	.106
4. Message variables			.043			.222***			.190**			.163**
PMQ	.063	.116		.149	.093		−.099	.077		.186	.088*	
PercInform	−.083	.108		.222	.086*		−.050	.071		−.031	.082	
PercAttract	−.070	.067		.000	.054		.047	.044		.014	.051	
5. PVI	.106	.077	.051	.168	.062**	.250**	−.146	.051**	.216**	.122	.059*	.177*
Constant	2.988	.728***		1.439	.583*		4.281	.480***		2.953	.551***	
N	253	252	253	253								

Note. Coefficients (*B*) and standard errors (*SE*) are for the final model in which all variables are entered. The R^2 column represents the amount of variance explained by all of the blocks included up to that point. Subtracting R^2 from the previous block will yield R^2 change (i.e., the amount of variance explained by that block alone). PVI = perceived visual informativeness; PMQ = perceived message quality; PercInform = perceived informativeness; PercAttrat = perceived attractiveness; V-V LP = visual/verbal learning preference (lower scores indicate verbal preference, higher scores indicate visual preference); VisFunction = visual function measured by the VF-14 (Steinberg et al., 1994), where higher scores indicate more visual ability; Pamphlet = identification of which of six pairs of images women received.

$^{\dagger}p < .10$. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

($k = 6$) information to determine whether PVI significantly predicts differences in both types of visual evidence.

Method

Participants ($N = 240$; $M_{age} = 20.14$; $SD = 1.95$) were recruited from undergraduate classes at a large Midwestern university and received extra credit for their participation. Most participants identified as White (69%; $n = 165$) or Asian/Asian American (22%; $n = 52$) and female (65%; $n = 155$). Study participation took place through an online interface; when participants clicked on a survey link through a research participation system they were randomly assigned to the original image condition (51%, $n = 123$) or cropped image condition (49%; $n = 117$). After reading through instructions, the 12 images from the first study were presented—randomly to control for order effects and without any accompanying text outside of what appears within the image—to all participants. For each image, participants completed the seven-item PVI measure. After participants were presented with the 12 images, they provided demographic information.

Results

The PVI measure demonstrated internal consistency across all 12 images (Cronbach's alpha ranged from $\alpha = .88$ to $\alpha = .94$). The primary hypothesis posited that participants would report higher PVI scores for the images that did not have the information cropped out. Results supported this claim, indicating PVI was higher in the original condition ($M = 3.44$, $SD = 0.43$) when comparing the mean of means for all 12 images to that of the cropped condition ($M = 2.82$, $SD = 0.57$), $t(238) = 9.51$, $p < .001$, Cohen's $d = 1.23$.

In addition, Study 2 was interested in determining whether PVI could detect differences in visual presentations of statistical and indexical information. For the images conveying statistical information, the original images ($M = 3.68$, $SD = 0.44$) received higher PVI scores than the images cropped to contain less information/evidence ($M = 3.16$, $SD = 0.67$), $t(238) = 7.07$, $p < .001$, Cohen's $d = .92$. Similarly, as hypothesized, the original images containing indexical evidence ($M = 3.21$, $SD = 0.55$) were perceived as having more visual information than the images in the cropped condition ($M = 2.48$, $SD = 0.60$), $t(238) = 9.803$, $p < .001$, Cohen's $d = 1.27$. The results from this small-scale experiment provide preliminary evidence for PVI being a modifiable message feature for both statistical and indexical information and evidence.[9]

Discussion

Evidence from the two studies suggests PVI is a visual message construct that can be used to assess and theorize visual information in printed health materials. Study 1 found PVI predicted important behavioral antecedents, even when accounting for well-established message constructs. The only construct of interest that PVI failed to predict was perceived susceptibility.[10] Study 2 provides evidence that PVI is

[9]In addition to the analysis reported, we performed t tests comparing PVI scores for all 12 individual images. For those t-tests, seven of the 12 images performed as predicted. Of the five images that did not perform as predicted, two were statistical and three were indexical.

[10]One potential explanation for the lack of relation is that most visuals were photographs of women having some type of breast cancer screening, medical illustrations presenting information about tumors and tumor growth, and charts or graphs presenting statistical information. Because women rated PVI for the entire pamphlet rather than individual visuals, the more objectively informative visual images addressing risk or incidence may not have been those addressing susceptibility and risk.

modifiable and should be considered in future message design theorizing. PVI should be investigated as an intervening variable in message theorizing. The modifiable nature of PVI also allows for future experimental manipulation of the construct, which will be useful in determining the theoretical role of PVI, as well as determining if the construct has predictive validity.

More work needs to be done to determine what structural features of images—such as color, photographic perspective, and frequency and dose of visual messages—affect the persuasiveness of visual messages independently, and alongside, of verbal messages. For example, it would be beneficial to develop a more objective coding scheme for visual messages that are visually informative, similar to the approach used in studying perceived message sensation value and more objective measures of message sensation value (e.g., Morgan et al., 2003). Such an approach for PVI would also allow for further study of visual message features rather than visual message effects. Studying features rather than effects is suggested for messages that might be used for suasory purposes, as it is an approach more likely to advance theoretical understanding and promote evidence-based message design than looking at effects alone (O'Keefe, 2003).

PVI also has practical implications. The relation between PVI and decision making satisfaction could be very important on future research in clinical settings. Given the essential role informed consent plays in the health care process, using visuals that facilitate thorough and thoughtful consideration of different medical procedures could enhance the quality of patient decision making. Another practical implication of the PVI results is that individuals using existing selection criteria for visuals (e.g., Buki et al., 2009; National Cancer Institute, 2007) could incorporate the seven-item measure in formative research to use a scale-based measure of visual message and material components. The measure complements approaches such as focus groups and interviews by providing a quantitative audience assessment of visual information to assist with the deeper understanding of preferences gained through qualitative research.

Future research on PVI might consider how it relates to a more objective scale of visual informativeness. PVI measures an individual's subjective appraisal of visual information/evidence. Some visual messages that convey complex relationships might be, more objectively, highly informative and present myriad evidence of some system of relationships but result in a relatively low PVI score. This could potentially result from a person feeling overwhelmed by too much visual stimuli and information within printed materials. Working to understand how people's perceptions of visual informativeness compare to the actual amount of visual information or evidence presented in a particular visual message will assist in determining how to construct and present visual messages to different audiences.

The present study helped provide an understanding of how PVI contributes to research on visual messages, but its contribution is likely limited to specific types of visual messages. PVI is unlikely to sufficiently account for the informativeness or persuasiveness of visual metaphors as it does not take into consideration the persuasive role of affect or processing of abstract manifestations of ideas or information. PVI is also not intended to assess intense or graphic visual messages that evoke emotions rather than provide information. Visual messages are often intended not to convey information in a traditional way, so as to take advantage of the syntactic indeterminate qualities of visual stimuli (e.g., Messaris, 1997; Niederdeppe, 2005). Some visual messages attempt to contextualize information and place individuals within larger policy or social contexts, where multiple data types, images, and messages are juxtaposed. Such visual messages may not be appropriately captured by PVI. In addition, PVI focuses primarily on the positive impact of visual messages. The presence of images does improve important health communication outcomes (see Houts et al., 2006), but researchers also need to consider the unintended effects of visual messages in health communication campaigns and interventions (see Cho & Salmon, 2007; Parrott, 2011).

Limitations

Some limitations of these studies merit discussion. Results of Study 1 may have limited generalizability because all participants were women. Future studies would benefit from having a random sample with visual messages addressing other health, science, or environmental topics. Another limitation, applicable to both studies, is that the samples were highly educated compared with the general population. For Study 2, the use of college students could be seen as a limitation because it was a convenience sample. The other limitation for Study 2 was that only text contained within an image was included, which is a design that does not fully consider text-image consistency (a main theoretical consideration of PVI).

Conclusion

PVI is an incremental step forward in attempting to better understand visual messages and their role in health campaign and intervention materials. Significantly more study and refinement of the construct is needed to meaningfully impact research or practice in health communication. The secondary goal of this article, besides introducing PVI, was to bring more focus on visual messages, and their features, in health communication research. For decades, print advertisements have focused on the visual components rather than the verbal or textual (Pollay, 1985), and, at least in the United States, society is continuing to be intensively visual (Lester, 2011). Health communication researchers need to continue considering how visual message features can help accomplish public health goals, whether it be through designing an attention-grabbing graphic for a health-promoting app, including high-quality visual information in tailored communication, or designing disgust-evoking visual messages for placement on cigarette packs (see Food and Drug Administration, 2010). PVI contributes to developing an empirical base for studying visual message in health communication, but there is considerably more to be done.

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