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Message Frames Interact with Motivational Systems to Determine Depth of Message Processing

Lijiang Shen
James Price Dillard

QUERY SHEET

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Q1: Au: "account" was changed to "possibility"; is this your intended meaning?
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Q3: Au: Should "expectancies" be "expectations"?
Q4: Au: Pls. update O'Keefe & Jensen, in press, if possible.
Q5: Au: Hale, Lemieux, & Mongeau, 1995, is not in the references; pls. add there or delete here.
Q6: Au: Pls. update O'Keefe & Jensen, in press, if possible.
Q7: Au: "at a lower threshold of zero": It is unclear what this means, specifically, "lower" in relation to what? Please clarify.
Q8: Au: Pls. spell out OLS on first use.
Q9: Au: Pls. check sentence beginning "This means that an OLS regression"; meaning as intended?
Q10: Au: Pls. update O'Keefe & Jensen, in press, if possible.
Q11: Au: Pls. note that "Caucasian" was changed to "White" per style.
Q12: Au: Can "feeling terms" be changed to "terms associated with emotions"?
Q13: Au: Millar & Millar, 2000, is not in the references; pls. add there or delete here.
Q14: Au: Cohen and Cohen (1983) is not in the references; pls. add there or delete here.
Q15: Au: "any evaluate thought" was changed to "any evaluative thought"; meaning as intended? Also, pls. note that "males" and "females" were changed to "men" and "women" per style for adults.
Q16: Au: Pls. check edits to the sentence beginning "Two tobit regression models": It is not clear to what "these" refers to in "these were entered…"; pls. clarify.
Q17: Au: Pls. update O'Keefe & Jensen, in press, if possible. Also, pls. note that part of the first sentence of the abstract is repeated here so that the reader will understand what is meant by "otherwise".
Q18: Au: Pls. update O'Keefe & Jensen, in press, if possible.
Q19: Au: Pls. update O'Keefe & Jensen, in press, if possible.
Q20: Au: Zuckerman et al., 1993, is not in the references; pls. add there or delete here.
Q21: Au: Pls. update O'Keefe & Jensen, in press, if possible.
Q22: Au: The sentence beginning "Depth correlated positively" is unclear, specifically "when individuals within the disadvantage frame"; pls. clarify.
Q23: Au: Cacioppo & Petty (1981) is not cited in the text; pls. add there or delete here.
Q24: Au: Newman et al. (1985) is not cited in the text; pls. add there or delete here.
Q25: Au: Pls. update O'Keefe & Jensen, in press, if possible.
Q26: Au: Pls. check edits to table footnote a; meaning as intended? Pls. define "OLS" in the table footnote.

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Message Frames Interact with Motivational Systems to Determine Depth of Message Processing

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Although several theoretical perspectives predict that negatively framed messages will be processed more deeply than positively framed messages, a recent meta-analysis found no such difference. In this article, the authors explore 2 explanations for this inconsistency. One possibility is methodological: the statistics used in the primary studies underestimated framing effects on depth of message processing because the data were maldistributed. The other is theoretical: the absence of a main effect is veridical, but framing interacts with individual differences that predispose individuals to greater or lesser depth of processing. Data from 2 experiments (*N*s = 286 and 252) were analyzed via tobit regression, a technique designed to overcome the limitations of maldistributed data. One study showed the predicted main effect for framing, but the other did not. Both studies showed the anticipated interaction: Depth of processing correlated positively with a measure of the behavioral activation system in the advantage framing condition, whereas depth of processing correlated positively with the behavioral inhibition system in the disadvantage framing condition. Q1

The idea that messages may be processed more or less deeply is a key assumption of dual-process models of attitude change and an essential tool for understanding the relative success of persuasive health messages (Slater, 2006). Evidence exists to show that more deeply processed messages can result in more extreme attitude, longer-lasting attitude change, attitude change that is more resistant to counterpersuasion, and an increased likelihood that attitude change might translate into behavioral change (Petty & Cacioppo, 1986). Thus, for both theoretical and applied reasons, it is important to understand the conditions that influence depth of message processing.

Among the many possible influences on depth of processing, message framing is an especially appealing candidate because of its clear implications for health message design. But, consider that "framing" can lead to several distinct ideas. Prospect theory (Tversky & Kahneman, 1981) uses *gain* and *loss* framing to refer to logically equivalent ways of expressing the same information (e.g., 10% fat vs. 90% lean). Mass communication researchers utilize the term to mean a central organizing idea or story line that provides meaning to an unfolding strip of events (e.g., Gamson, 1992). We prefer to contrast *advantage* with *disadvantage* framing. The advantage frame focuses on the benefits and desirable outcomes of complying with its advocacy; whereas the disadvantage frame emphasizes the cost and undesirable consequences of not adopting the recommendation. Although advantage/disadvantage frames encompass the linguistic variation that is part of prospect theory's gain/loss distinction, similar to media framing they also recognize the potential for substantive differences in argument content. The goal of this article is to further our understanding of message processing when persuasive appeals are presented in each of the two frames. Such knowledge has powerful ramifications for health communication because virtually all persuasive health messages

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must, of necessity, build the appeal on the argumentative basis of gains or losses. Understanding the conditions under which each frame is most suitable (if such conditions exist) would enable the development of more effective campaigns for public health.

MESSAGE FRAMES AND DEPTH OF PROCESSING

Several theoretical approaches attempt to explain how advantage/disadvantage frames might systematically lead to different levels of message processing. Perhaps the most frequently mentioned of these is negativity bias, a phenomenon that occurs when individuals assign greater weight to negatively valenced information than positively valenced information, even when they are equivalent in intensity (Rozin & Royzman, 2001). Negativity bias is the premise for the S-shape function in prospect theory. It suggests that individuals tend to pay more attention to the disadvantage frame than the advantage frame, and that the former tends to invoke greater message processing.

A second approach to predicting framing effects on depth of message processing is rooted in the elaboration likelihood model. This approach considers the inherent valence associated with the two frames as peripheral cues (e.g., Maheswaran & Meyers-Levy, 1990) that affect subsequent message processing. Smith and Petty (1996) suggest that the disadvantage frame would be processed more carefully because it is more attention grabbing and/or it is more likely to violate individuals' expectancies.

A third position, which also suggests deeper processing as a consequence of the disadvantage frame, draws from research on fear appeals. Conceptually and operationally, the disadvantage frame and the threat-to-health component of a fear appeal message share certain common characteristics (O'Keefe & Jensen, in press). In addition, empirical research has shown that the disadvantage frame arouses more fear than the advantage frame (e.g., Shen & Dillard, 2007). Other research shows that fear can increase message processing (e.g., Hale, Lemieux, & Mongeau, 1995; Slater, Karan, Rouner, & Walters, 2002). Lazarus's (1991) cognitive–motivational–relational theory also suggests that the function of fear is to protect the individual from risks. Thus, fear motivates individuals to seek and process information that offers protection from the risks described in the message (e.g., Nabi, 2003).

The best available empirical evidence, however, refutes all three perspectives. O'Keefe and Jensen's (in press) meta-analysis found (a) no main effect of message frame on the number of evaluative thoughts participants list, and that (b) the advantage frame actually led to better recall than the disadvantage frame. Caution is needed, however, in interpreting these results because a meta-analysis is only as good as the primary studies on which it is based. In addition, there is reason to believe that the primary studies may share a common flaw.

In laboratory settings, participants' motivation to process messages may be low, such that many of them report nothing during the thought-listing task. The empirical result is that the distribution of message-relevant evaluative thoughts may be censored at a lower threshold of zero. Censoring occurs when there is a considerable proportion of cases clustered at a threshold value, yet there remains substantial variance above the threshold. Although data transformation techniques (e.g., square, square root, and log) can reduce skewness and improve normality, they are not of much help in this case. First, data transformations are not effective in reducing censoring: They do not have any impact on the cases at the censoring threshold—they will always have the same value. Second, the censored distribution might be the inherent nature of message processing measured by number of evaluative thoughts, which is at a ratio scale and cannot take negative values. Transforming such data might be undesirable.

In such cases, linear estimators used to calculate effect sizes in meta-analysis (e.g., mean comparison) tend to underestimate the effects of predictors on the outcome and to fail to detect significant predictors when the effect sizes are small (e.g., Baba, 1990). Figure 1 demonstrates the underestimation of a linear estimator (e.g., OLS regression) when the dependent variable is censored. The left panel presents the OLS regression line when the dependent variable is censored at a lower end. The right panel presents what the regression line (the lighter one) would have been compared to the OLS regression line (the thicker one), had there not been censoring. Another problem of a linear estimator is that it is possible that there would be negative predicted values, which do not make sense in this case because one cannot have a negative number of cognitive responses. This means that an OLS regression model will be a misspecification for predicting depth of processing for a message whose distribution is censored at zero. OLS coefficients will underestimate the "true" effect. Instead, the tobit estimator (Tobin, 1958) is considered more appropriate for dependent variables with censored distributions. Therefore, there may be merit in exploring the effect of message frame on depth of processing when the censored distribution is taken into consideration. Despite the meta-analytic results, the three theoretical perspectives previously outlined are univocal in their anticipation of a main effect for framing such that

H1: The disadvantage frame will be processed more deeply than the advantage frame.

Regarding the censored distribution of the dependent variable, we have the following research question:

RQ: Will tobit regression yield more robust estimates than OLS regression?

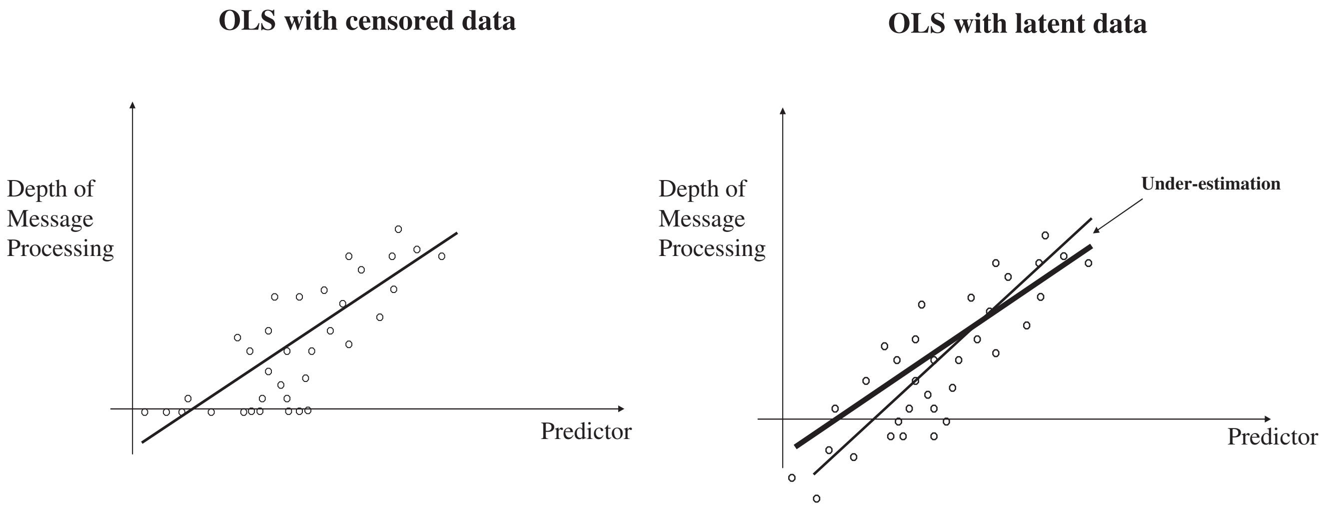

FIGURE 1 Censored dependent variable and under-estimation of linear estimator. *Note.* The left panel presents the OLS regression line when the dependent variable is censored at a lower end. The right panel presents what the regression line (the lighter one) would have been compared to the OLS regression line (the thicker one), had there not been censoring. The slope of the OLS regression line is smaller than it would have been, had there not been censoring.

BIS/BAS, MESSAGE FRAMING AND DEPTH OF PROCESSING

Q10 The second explanation for O'Keefe and Jensen's (in press) null findings is theoretical. Motivational theories agree that there are two brain systems that guide responses to stimuli of reward and punishment (e.g., Thayer, 1989). The behavioral activation system (BAS) is sensitive to cues of reward, nonpunishment, and escape from punishment. The behavioral inhibition system (BIS) is the source of aversive motivation that arises in response to cues associated with punishment, nonreward, and novelty (Gray, 1990). Research has established individual differences in chronic activation levels of BIS and BAS, as measured via electroencephalograph (EEG; Sutton & Davidson, 1997). The nature of the BIS/BAS systems and the defining features of advantage versus disadvantage frames suggest that BIS should be sensitive to disadvantage framing, whereas BAS should respond to advantage framing. Therefore,

H2: Under advantage framing, depth of message processing will be associated with BAS, but not BIS.
H3: Under disadvantage framing, depth of message processing will be associated with BIS, but not BAS.

METHOD

Overview

Two studies were conducted that were conceptual replications of one another. Experimenter-designed messages on skin cancer, obesity, and influenza were used as stimuli in Study 1, whereas professionally produced television public service announcements (PSAs) concerning smoking, glaucoma, and pedestrian safety were used in Study 2. Synopses of the messages are presented in Shen and Dillard (2007). Similar measures were used in both studies; however, message sensation value was measured only for the PSAs in Study 2.

Experimental Design

The study was a 2 (Message Frame) × 3 (Message Topic) × 3 (Message Sequence) mixed design, with message topic and message frame as within-subject factors, and message sequence as a between-subject factor. Each participant was exposed to three messages, one from each topic, presented in either frame. The sequences were 1, 2, 3; 3, 1, 2; and 2, 3, 1. The outcome of this design was that one fourth of the sample viewed advantage framing only, one fourth viewed disadvantage framing only, one fourth viewed one advantage-framed message and two disadvantage-framed messages, and one fourth viewed one disadvantage-framed message and two advantage-framed messages.

Participants

All participants were recruited from undergraduate classes in communication/journalism at the University of Wisconsin–Madison. They received a small portion of extra credit for participating in the study. The 286 participants in Study 1 ranged in age from 18 to 37 years (M = 20.00, SD = 1.61), and 86% described themselves as White, 9% as being of Asian descent, 2% as being of Hispanic descent, 2% as Q11
being of African descent, and 1% as other. The sample was 73% female and 27 % male. The 252 participants in Study 2

ranged in age from 18 to 43 years (M = 20.29, SD = 2.24), and 86% described themselves as White, 10% as being of Asian descent, 1% as being of Hispanic descent, 2% as being of African descent, and 1% as other. Seventy one percent reported their sex as female and 29% reported it as male.

Procedure

The two studies followed the same procedure. When the participants arrived at the laboratory, they were informed that their task would be to evaluate some media messages on health topics relevant to college students. They were randomly assigned to 1 of the 18 experimental conditions. Participants signed and returned consent forms to the experimenter before they received the questionnaire. The participants read the messages on a computer screen at their own speed in Study 1, and watched the PSAs on a computer screen in Study 2. They read/watched the first message before they provided affective responses on closed-ended scales (reported in Shen & Dillard, 2007), then listed whatever thoughts came to mind when they were reading the message in open-ended format. Next, they answered questions about their attitudes toward and intention to comply with the message advocacy (reported in Shen & Dillard, 2007). The same procedure was repeated for the second and third messages. Finally, they responded to the BIS/BAS scales (Carver & White, 1994) and provided demographic information. The sessions were roughly 40 min in length. The participants were thanked and their questions answered before they left the lab. Participants in Study 2 responded to the message-sensation-value questions after the thought-listing task.

Measures

Confirmatory factor analyses showed that scales used to measure each variable were all unidimensional. All multi-item scales were summed, then divided by the number of items.

Induction check. The check for message framing manipulations was measured by 7-point (–3 to +3) semantic differential items. In Study 1, the participants were asked to make a judgment about the emphasis of the message on the following word pairs: costs/benefits; loss/gain; and negative/positive outcomes (α = .93). There was one additional word pair in Study 2: advantage/disadvantage (α = .97).

Cognitive responses. Three coders received 5 hr of training before they started coding the first fifth of the data. Reliabilities were checked for this portion of the data, then the remaining data were divided among the three research assistants and coded by one person only. Coding took place in four steps. First, the coders segmented the data into psychological thought units (roughly, independent clauses). The coders agreed on 93% to 96% of the thought units. Guetzkow's U (Guetzkow, 1950) was around .02 for all pairs of coders in both studies, indicating there was 2% of disagreement in coders' unitization after chance was adjusted for.

Second, emotional responses were culled from the open-ended cognitive response data. Coders used a list of feeling terms compiled by Shaver, Schwartz, Kirson, and O'Connor (1987), supplemented by emotional words provided by the participants. A unit was classified as affective whenever those Q12 words appeared. The reliability for this step was κ = 1.00 for all coder pairs.

Third, coders evaluated the relevance of the cognitive responses to the message. The purpose of this step was to screen irrelevant responses and thereby reduce the level of noise in the data. Relevant thoughts were those related to the message (i.e., content or delivery), the particular health problem addressed in the message, or the message advocacy. Irrelevant thoughts were words not associated with the task. For example, "I'm hungry" was coded as irrelevant. The kappas for this step ranged from .94 to .98.

Finally, cognitive responses were also coded as favorable, neutral, or unfavorable. Favorable responses expressed a positive sentiment toward the message or the source (e.g., "I should tell my friends about this message" and "This is clever!"). Neutral thoughts were those that did not express an evaluation (e.g., "[This is] another anti-smoking PSA"). Unfavorable thoughts were critical of the message or the source (e.g., "Money can be better spent than making such a PSA"). Reliability for this step ranged from .79 to .84. An index of depth of message processing was created by summing the number of negative thoughts and positive thoughts that each participant generated. This is different from the valence coding, which is computed by subtracting the number of each subject's negative thoughts from the number of positive thoughts. Thus, higher values indicated more evaluative thoughts and greater depth of processing. This is the most common sort of cognitive response coding to measure depth of message processing (e.g., Jones, Sinclair, & Courneya, 2003; Maheswaran & Meyers-Levy, 1990; Millar & Millar, 2000). Q13

Behavioral inhibition and activation systems. BIS was measured by 7 and BAS by 13 Likert-type items taken from Carver and White (1994). Respondents were presented with 5-point response scales anchored at either end with 1 (*strongly disagree*) and 5 (*strongly agree*). Sample items from the BIS scale include "If I think something unpleasant is going to happen I usually get pretty worked up" and "I worry about making mistakes." Sample items from the BAS scale include "When I get something I want, I feel excited and energized" and "When I want something I usually go all-out to get it." Alpha reliability for BIS and BAS ranged from .77 to .82 in both studies.

Message sensation value. Ten features of the scale of message sensation value (Morgan, Palmgreen, Stephenson, Hoyle, & Lorch, 2003) were used to measure the perceived video/audio features of the PSA messages: cuts, special visual effect, slow motion, unusual colors, intense images, sound saturation, sound effects, acted out (vs. talking head), unexpected format, and twist ending. The music judgment included in Morgan et al. was not retained because it did not predict perceived message sensation value in their investigation. For each dimension, 0 = lack of this feature, and 1 = this feature is present. Morgan et al. provided empirical evidence that the subjective message sensation value is associated with the formal and content features of the PSA messages. These 10 dimensions of subjective message sensation value were summed to create a scale of message sensation value. Because this is a formative as opposed to reflective measure, internal consistency between the items was of minimal importance.

Analytic strategy

Table 1 presents the descriptive statistics for depth of message processing within each of the six messages across the two studies. The average number of evaluative responses participants reported ranged from .53 to 1.63. There are considerable numbers of cases clustered at zero, ranging from 23.8% to 32.9% of the sample. Yet there remained substantial variance above zero: With the cases clustered at 0 removed, variance in depth of message processing ranged from 1.94 to 2.77. These statistics illustrate the censored distribution of the variable and suggest that estimates from linear models may be biased; thus, the potential value of the tobit model.

The tobit procedure simultaneously estimates (a) a marginal effect, which refers to the impact of the predictors on the *likelihood* (above and beyond chance) of the dependent variable passing the threshold, and (b) a linear effect, which is the impact of the predictors on the dependent variable given that it is already above the threshold. In the case of this study, the marginal effect refers to the impact of predictors on the likelihood that a participant would generate any evaluative thought above and beyond chance (i.e., 50%). The linear effect refers to the impact of predictors on number of evaluative thoughts among those who reported at least one evaluative thought. From a substantive standpoint, tobit coefficients cannot be directly interpreted until they are decomposed into these two effects. In addition, there is no statistic in tobit model that is equivalent to ΔR^2 in OLS regression as an indicator of amount of variance explained. Change in Cragg and Uhler's R^2 ($\Delta R^2_{C\&U}$)is preferred as an indicator of proportion of variance explained in tobit models because it has a range of 0 to 1 and is comparable to ΔR^2 in OLS. A likelihood ratio test of two nested models (i.e., a null model vs. a specified model) can be used for model evaluation and comparison (see Long & Freese, 2001, for a discussion of model fit indexes).

TABLE 1
Censored Distribution of Depth in Message Processing

Message	*M*	*SD*	*Proportion of Censoring*	*Variance Above 0*
Study 1				
Overall	1.56	1.66	31.7%	2.40
Skin cancer	1.62	1.66	30.1%	2.33
Obesity	.53	1.73	32.9%	2.77
Influenza	1.52	1.60	32.2%	2.15
Study 2				
Overall	1.58	1.54	27.6%	1.99
Smoking	1.63	1.55	23.8%	2.06
Glaucoma	1.58	1.55	29.0%	1.94
Pedestrian safety	1.53	1.54	30.0%	1.95

Note. Sample sizes for Studies 1 and 2 were 286 and 252, respectively. Because each study utilized three messages, the corresponding numbers of observations were 858 and 756, respectively.

RESULTS

Induction Check

A linear mixed models procedure was used to check the manipulation of message frame, with message frame, the interaction term between frame and topic, message sequence, and sex as fixed-effects factors; message topic nested within frame as a repeated-effects factor; and age as a covariate. The model was estimated via restricted maximum likelihood procedures. In Study 1, there was a significant effect of frame: $F(1, 790.93) = 370.13$, $p < .001$, $\eta^2 = .32$. Messages in the disadvantage frame were perceived as focusing on costs ($M = –1.48$, $SD = .08$), whereas messages in the advantage frame were perceived as emphasizing benefits ($M = .42$, $SD = .08$). Both marginal means were significantly different from 0: $t = –19.79$, $p < .001$, for the disadvantage frame, and $t = 5.63$, $p < .001$, for the advantage frame. The main effect of frame was qualified by a significant interaction between frame and topic: $F(4, 270.23) = 34.80$, $p < .001$, $\eta^2 = .34$. Post hoc analyses showed that this interaction was due to partial failure of manipulation for the skin cancer message. The advantage-framed messages were perceived as emphasizing costs ($M = –.58$, $SD = .14$), although significantly less so than the disadvantage counterpart ($M = –1.95$, $SD = .11$). Means of other conditions were all in the intended direction and significantly different from 0.

The main effect of message frame was significant in Study 2 as well: $F(1, 705.34) = 1134.58$, $p < .001$, $\eta^2 = .62$. Messages in the disadvantage frame were perceived as focusing more on costs ($M = –1.95$, $SD = .06$); whereas messages in the advantage frame were perceived as emphasizing benefits ($M = 1.19$, $SD = .70$). Both marginal means were significantly different from zero: $t = -32.5$, $p < .001$, for perceived disadvantage frame, and $t = 17.82$, $p < .001$, for the advantage frame. This effect of frame was qualified by a significant interaction between frame and topic: $F(4, 306.02) = 86.40$, $p < .001$, $\eta^2 = .46$. Post hoc analyses showed that the perceived advantage frame for the anti-smoking PSA was more salient (*M* = 2.44, *SD* = .08) than the glaucoma PSA (*M* = .84, *SD* = .13), which was more salient than the pedestrian safety PSA (*M* = .30, *SD* = .12). On the other hand, the perceived disadvantage frame for the anti-smoking PSA was perceived as more salient (*M* = –2.57, *SD* = .07) than either the glaucoma PSA (*M* = –1.71, *SD* = .11) or the pedestrian safety PSA (*M* = –1.56, *SD* = .13), which did not differ in salience. All marginal means were in the intended direction and significantly different from 0.

H1: Main Effect of Message Framing on Depth of Processing

Two tobit models were estimated, with depth of message processing as the criterion. The first model was the null model, with demographic variables, dummy variables for message topic, and message sequence as predictors. Message sensation value was an additional covariate in Study 2. Message frame (advantage frame coded as 1 and disadvantage frame as –1) was added in the full model as an additional predictor. Two OLS models with the same specifications were also run for the purpose of comparison. With such parameters, statistical power to detect an effect size equivalent to $\Delta R^2 = .01$ was .83 in Study 1 and .76 in Study 2.

Across the two studies, none of the dummy variables for message topic or sequence were significant predictors. This means that individuals' message processing did not vary in depth across the three message topics or message sequences. There was no significant main effect of age either. Sex, however, was a significant predictor in Study 1 ($\beta = .97$, $p < .001$). Women processed the messages more systematically than men. The decomposed tobit coefficient showed that they were 15.5% more likely to generate any evaluative thought than men, and when they did, on average Q15 they had .67 more thoughts. Message sensation value was not a significant predictor in Study 2 ($\beta = .02$, $p < .64$).

H1 predicted that individuals would process the disadvantage frame more systematically than the advantage frame. The main effect of framing on depth of message processing was nonsignificant in Study 1 ($\Delta R^2_{C\&U} = .00$, $\beta = -.01$, *ns*; OLS results: $\Delta R^2 = .00$, $\beta = -.00$, *ns*), which means the participants are equally likely to generate any evaluative thoughts to either frame; and when they do, they have equal numbers of evaluative thoughts. On the other hand, the main effect of message framing was significant in Study 2 ($\Delta R^2_{C\&U} = .008$, $\beta = -.10$, $p < .05$; OLS results: $\Delta R^2 = .006$, $\beta = -.08$, $p < .05$), suggesting that the disadvantage frame leads to deeper message processing than the advantage frame. The unstandardized tobit coefficients were decomposed into a marginal effect and a linear effect: The marginal effect of frame was –5.0%, meaning that participants exposed to the disadvantage frame had a 5% greater chance of generating at least one evaluative thought than those exposed to the advantage frame. The linear effect was –.12, meaning among those who reported at least one evaluative thought, on average, the disadvantage frame led to .12 more evaluative thoughts than the advantage frame. Further analyses showed, however, that the difference in the marginal likelihood was nonsignificant, whereas the linear effect was significant ($p < .01$).

H2: BIS/BAS and Depth of Message Processing Under the Advantage Frame

Two tobit regression models were run within the advantage frame to test H2, with depth of message processing as the criterion, and the demographic variables and the dummy variables for message topic and sequence as covariates; these were entered in the null model as predictors. Q16 Message sensation value was added as an additional predictor in the null model for Study 2. BIS and BAS were entered in the full model. Two OLS regression models with the same specifications were also run for comparison purposes. The top panel in Table 2 presents the results of these analyses. Within each study, the first row presents the variance explained by the null model. The second row presents the additional variance explained by BIS and BAS combined. The last two rows present the standardized regression coefficients, and the two decomposed unstandardized tobit coefficients for BIS and BAS.

There are two parts to H2: under the advantage frame, (a) depth of message processing is associated with BAS but (b) not with BIS. The main effect of BAS on depth of message processing was significant in both Study 1 ($\beta = .12$, $p < .05$) and in Study 2 ($\beta = .20$, $p < .001$). Therefore, the first part of H2 was supported. The decomposed tobit coefficients indicate that within the advantage frame (a) increase of one unit in BAS leads to 9.5% (Study 1) and 15.0% (Study 2) greater likelihood above and beyond chance (i.e., 50%) for the participants to report at least one evaluative thought; and (b) increase of one unit in BAS led to an additional .39 (Study 1) and .59 (Study 2) evaluative thoughts when participants generated at least one evaluative thought.

The main effect of BIS was also significant in Study 1 ($\beta = .18$, $p < .01$). Post hoc analyses showed that the main effect of BIS was probably due to the failure in manipulation for the skin cancer message. When the skin cancer data were dropped, that effect disappeared ($\beta = .11$, *ns*). Dropping that proportion of the data did not change of the effect of BAS on processing of the advantage frame. The main effect of BIS was nonsignificant in Study 2 where manipulation was successful for each message topic ($\beta = -.08$, *ns*).

TABLE 2
Using BIS/BAS to Predict Depth of Message Processing

		Block/Predictor	ΔR^2	Standardized OLS Coefficient	$\Delta R^2_{C\&U}$	Standardized Tobit Coefficient	Decomposed Effects: Marginal	Decomposed Effects: Linear
Advantage frame	Study 1[b]	Covariates[a]	.038		.040			
		BIS/BAS	.022*		.024*			
		BIS		.11		.11	6.3%	.28
		BAS		.13*		.14*	9.5%	.39
	Study 2	Covariates[a]	.020		.025			
		BIS/BAS	.024*		.038***			
		BIS		−.08		−.08	−4.2%	−.17
		BAS		.19		.20***	15.0%	.59
Disadvantage frame	Study 1	Covariates[a]	.017		.023			
		BIS/BAS	.017*		.025*			
		BIS		.14**		.16**	9.0%	.39
		BAS		.05		.07	5.3%	.22
	Study 2	Covariates[a]	.012		.025			
		BIS/BAS	.037**		.038***			
		BIS		.21**		.29***	9.2%	.45
		BAS		.08		.16	6.1%	.29

Note. BAS, behavioral activation system; BIS, behavioral inhibition system; Cragg and Uhler's ΔR^2.
[a]Sex and age were dummy variables for message topic and sequence, respectively, in Study 1. Message sensation value added in Study 2.
[b]With skin cancer data dropped.
Q26 *$p < .05$. **$p < .01$. ***$p < .001$.

The power analysis previously described suggests that we should accept the null portion of H2 with confidence in the .76 to .83 range. These results demonstrate that the second part of H2 also received support from the data. Comparison of the effects of BAS and BIS on depth of message processing following the Cohen and Cohen (1983) procedure (pp. 53–55) showed that they were not significantly different in Study 1 but were significantly different in Study 2. Q14

H3: BIS/BAS and Depth of Message Processing Under the Disadvantage Frame

Two tobit regression models were estimated within the disadvantage frame to test H3, with the same specifications for the models in H2. Two OLS regression models with the same specifications were also run for comparison purposes. The bottom panel in Table 2 presents the results of these analyses. Within each study, the first row presents the variance explained by the null model. The second row presents the additional variance explained by BIS and BAS combined. The last two rows present the standardized regression coefficients, and the two decomposed unstandardized tobit coefficients for BIS and BAS.

There are two parts in H3 as well: under the disadvantage frame, (a) depth of message processing is associated with BIS but (b) not with BAS. The main effect of BIS on depth of message processing was significant in both Study 1 ($\beta = .16$, $p < .05$) and Study 2 ($\beta = .29$, $p < .001$). Therefore, the first part of H3 was supported. The decomposed tobit coefficients indicate that when exposed to the disadvantage frame, (a) an increase of one unit in BIS led to 9.0% (Study 1) and 9.2% (Study 2) greater likelihood above and beyond chance (i.e., 50%) for participants to report at least one evaluative thought, and (b) an increase of one unit in BIS led to an additional .39 (Study 1) and .45 (Study 2) evaluative thoughts when participants had at least one evaluative thought.

The main effect of BAS was nonsignificant in both Study 1 ($\beta = .07$, *ns*) and Study 2 ($\beta = .15$, *ns*). The power analysis previously described suggests that we accept the null portion of H3 with confidence in the .76 to .83 range. Further analyses showed that the effect of BIS was significant on likelihood and intensity of processing as well in both studies. In both studies, the effects of BIS and BAS on depth of message processing were significantly different from each other. These results demonstrated strong support for H3. The variance explained by the block of BIS and BAS, and their standardized coefficients in OLS were slightly smaller than those from the tobit analyses.

DISCUSSION

Linear Statistics as an Explanation for the Absence of a Framing Effect on Processing

Despite the consistent predictions from three theoretical approaches to the main effect of frame on depth of message processing that negatively framed messages will be processed more deeply than positively framed messages, a recent meta-analysis reported otherwise (O'Keefe & Jensen, Q17 in press). On the other hand, the depth of message processing data probably formed a censored distribution, which might lead to underestimation biases in linear estimates. Inspection of our data revealed that, indeed, the distribution of cognitive responses was censored, which suggested that our speculation might have merit. This censored distribution is particularly noteworthy given that the participants were instructed to evaluate these messages, yet a considerable proportion of observations of the dependent variable were clustered at zero.

Regression models were estimated via both tobit and OLS in testing H1. There were only relatively small differences between the OLS and tobit results. Neither reached significance in Study 1. In Study 2, the tobit model explained more variance than OLS, and the obtained tobit effect size was larger than the effect size of the OLS estimate. The increase in explained variance might seem small (.008 vs. .006); however, it should be noted that such improvement is conditional on the "true" population effect. If the "true" population effect size is equivalent to $R^2 = .01$, the absolute improvement of tobit over OLS cannot be bigger than .01. Thus, it is meaningful to consider the advantage of tobit estimates over OLS in relative terms, which, in this case is 33.3%. This pattern was consistent across the analyses for H2 and H3 as well.

The relative differences between the two methods permitted two conclusions. First, tobit analysis does have a considerable relative advantage over OLS in studies of cognitive responses to framing manipulations. However, cognitive response is only one way of measuring message processing. It is not known whether this relative advantage holds for other methods. Second, despite that fact that we observed some support for those theories that predict a main effect for framing, the effects were not nearly large enough to challenge the conclusions of O'Keefe and Jensen's (in Q18 press) meta-analysis. Regardless of the method of analysis or level of significance, the effect sizes of the framing effect were so small as to be of no practical concern.

One remaining concern is that the tobit and OLS regression models do not account for the interdependence in the data introduced by the mixed designs. Two sets of additional analyses were conducted to explore possible biases involved in the reported tobit analyses: (a) tobit analyses were performed within each message topic. These results were in very similar patterns compared to the pooled data. In addition, (b) random-effects tobit analyses were conducted. The differences between the tobit and random-effects tobit results were minimal, thereby suggesting that it is unlikely that interdependence threatens our conclusions.

An explanation for the different results regarding the main effect of framing in the two studies might be involvement. Perhaps the PSAs were more engaging than the experimenter-designed messages. To explore this possibility, data from the two studies were pooled and tobit analyses were conducted. The results showed that individuals had slightly more evaluative thoughts in Study 2 ($M = 1.58$, $SD = 1.54$) than in Study 1 ($M = 1.56$, $SD = 1.66$); however, this difference was nonsignificant ($\beta = .12$, $p < .30$). This means the possibility of a methodological bias between the two studies that is a function of message differences in involvement is unlikely.

The Interaction of Message Framing and Motivational Systems

A second aim of this project was to subject to empirical test the notion that frames interact with the BIS and BAS motivational systems. Both studies provided evidence compatible with this expectation. In both investigations, depth of message processing was associated with BIS under the disadvantage frame and with BAS under the advantage frame. Of equal importance to our theorizing, depth was not associated with BIS in the advantage-framed conditions and was not associated with BAS in the disadvantage-framed messages. Together the significant associations and the statistically powerful null results lend credence to the notion that message frames are elements of the broader class of stimuli that are capable of activating BIS and BAS. These findings are of considerable import insofar as they suggest that framing effects on depth of processing do occur, but that they are more complex than previously thought. Of course, additional research that replicates the effects found here would be needed to instill confidence in the durability of our findings.

Limitations and Directions for Future Research

We see two features of this project that are properly viewed as limitations. One is our measure of BIS and BAS. The Carver and White (1994) instrument is well validated and has been shown to correspond with electroencephalographic measures of hemispheric activation (Sutton & Davidson, 1997). But, for all its virtues, it remains an individual-difference measure of chronic BIS/BAS activation and cannot, therefore, provide direct evidence of momentary stimulation of the motivational systems. Future research that uses more temporally sensitive measurement (e.g., electroencephalograph or functional magnetic resonance imaging) is needed to buttress our claims regarding the activation of the two motivational systems as a function of message framing.

A second limitation concerns the use of cognitive responses as a means of assessing depth of processing. The O'Keefe and Jensen (in press) meta-analysis shows some variation in the effect size of framing effects on processing as function of type of measurement. Specifically, framing Q19 effects were noticeably larger when memory measures were used to index depth than when cognitive responses were used for the same purpose. In our view, such a finding does not threaten the validity of our results so much as it makes plain the fact there is more than one way to assess processing and that each of those methods may tap unique sources of variance. Thus, we suggest that our conclusions would be strengthened if future studies were able to demonstrate similar effects utilizing other forms of measurement (e.g., memory or reaction time).

A third limitation arises from the issue of censored data from thought-listing task. Our study is the first to report the possibility of censored data using this method. Because detection of censored distribution requires examination of frequency statistics or the primary data, which communication research usually does not report, we do not have empirical evidence for its prevalence. It is possible that not all studies employing thought-listing procedure would result in censored distribution in message processing. For example, censored distribution is less likely to occur when messages longer than 30 sec, or messages in print instead of PSAs, are used.

Implications for Persuasive Health Communication

Dual-process models of attitude change rely heavily on depth of processing to help explain a myriad of effects. In general, they contend that deeper message processing is conducive to persuasive health communication aimed at behavior change (Petty & Cacioppo, 1986). But there is one crucially important condition that is necessary to assuring these outcomes: The arguments in the message must be seen as subjectively compelling by the message recipient. If they are not, boomerang effects are likely. Still, if this condition can be met, encouraging deeper processing by the message recipients has the potential to substantially enhance suasory impact.

The implementation of efforts to enhance depth of processing requires the researcher to make one or more assumptions about the distribution of BIS/BAS values in the target population. If one assumes that BIS and BAS are normally distributed in the population, then either one of the frames can be used with limited success. However, persons who fall below the mean BIS or BAS are not likely to be responsive because their chronic system activation level is low. It may be that one means of addressing this problem would be to incorporate into any given campaign messages in each of the two frames. The fact that BIS and BAS were minimally correlated (in our data) with the alternative frame implies that the simultaneous utilization of both forms would not have the effect of producing strong countervailing persuasive forces. Rather, simultaneous utilization should simply double the effective range (across persons) of the campaign.

A different strategy might be attempted if the researcher is willing to assume or empirically determine that the distribution of BIS/BAS in the target population is nonnormal. For example, Franken and Muris (2006) report a positive association between BAS and the frequency and quantity of alcohol consumption. This suggests that binge drinkers form a naturally occurring high-BAS group and, as such, they should be especially receptive to advantage-framed messages. But, the multifunctional nature of BAS introduces some complexity here. Recall that BAS is both sensitive to rewards (i.e., advantages) and it is the source of goal-directed motivation. BIS provides an inhibitory motivation that restrains behavior that could harm the organism. Thus, a message that urges individuals to "Limit your drinking. There are many benefits to doing so," presents a behavioral advocacy that should stimulate the BIS but a rationale that should activate BAS. In the absence of research on the interaction of the motivational systems, it is difficult to offer advice other than caution in the implementation of messages that combine the frames.

Locating BIS and BAS in the Health Communication Literature

Because BIS and BAS are relative newcomers to the health communication literature, it may be useful to examine them in more detail and to analyze their relationship to the better-known concept of sensation seeking. The BIS/BAS measure employed in this study (i.e., Carver & White, 1994) was designed to tap individual differences in reactivity to two classes of stimuli. The two motivational systems are conceived of as capable of varying degrees of activation independent of the operation of the other system. In individual-difference terms, this means that we should anticipate all possible combinations of scores on the two scales in the population. Indeed, the two scales correlated at –.01 (*ns*) and .23 ($p < .05$) in our two studies (mean $r = .11$), suggesting that the chronic activations of the two systems are largely independent of one another.

Comparison of the BIS/BAS scales with measures of sensation seeking is instructive. Consider items from the sensation-seeking subscale of the Zuckerman-Kuhlman Personality Questionnaire (Zuckerman, Kuhlman, Joireman, Teta, & Kraft, 1993): "I like doing things just for the thrill Q20 of it," "I sometimes do 'crazy' things, just for fun," and "I enjoy getting into new situations where you can't predict how things will turn out." These look very similar to the items that comprise the fun-seeking subscale of Carver and White's (1994) BAS instrument: "I will often do things for no other reason than that they might be fun," and "I crave excitement and new sensations." There is no question that there is substantial conceptual overlap here. However, the Carver and White scale indexes two additional subdimensions of BAS, that is, reward responsiveness (e.g., "When I get something that I want, I feel excited and energized") and drive ("When I want something, I usually go all-out to get it"). Second-order factor analysis reduces the three BAS subscales to a single factor (Carver & White, 1994). Given its component scales, the second-order factor is clearly broader than sensation seeking. From this perspective, sensation seeking might be considered conceptually subordinate to BAS. By implication, segmenting audiences in terms of BAS might have a broader conceptual reach. However, sacrificing the specificity of sensation seeking may produce a decline in predictive power.

Another perspective is possible. Sensation seeking is seen as more or less synonymous with impulsivity (Gray, Owen, Davis, & Tsaltas, 1983). Indeed, one of the sensation-seeking items is "I am an impulsive person." Further, impulsivity might stem from either a strong appetitive system or a weak inhibition system (see Stephenson & Southwell, 2006, for a similar analysis). From this vantage point, then, impulsivity has no independent conceptual status; it is simply the difference between the chronic activation levels of BIS and BAS. This raises the question of whether or not there might be something to be gained by focusing on the antecedents of sensation seeking, rather than the resulting difference. For instance, does a person with BIS/BAS difference at high levels of activation behave similarly to a person with a BIS/BAS difference at low levels of activation? The results of this study, in which message features interacted with one motivational system and not the other, suggest that there is a payoff for adopting the two-system view. But, a more certain answer would require an investigation in which both BIS/BAS and sensation seeking are measured.

SUMMARY AND CONCLUSION

Two experimental studies were carried out to explore if and when message framing might produce variations in the depth of processing of persuasive health messages. There was evidence that the depth of processing data might be censored at a lower threshold and that a linear estimator such as OLS regression could, therefore, underestimate the effect of framing on processing. However, there was very little in the way of substantive differences in the conclusions drawn from the OLS versus the tobit estimators. Both showed a small main effect for framing in one study and no significant effect in the other. Thus, it seems unlikely that censored data can explain the absence of a framing effect in
Q21 O'Keefe and Jensen's (in press) meta-analysis.

Clear evidence was obtained for an interaction between BIS/BAS and framing on depth of message processing. Depth correlated positively with BIS when individuals within the disadvantage frame, but manifested a direct rela-
Q22 tionship with BAS within the advantage frame. These results suggest that framing effects do exist but that they are moderated by individual differences in sensitivity to each message frame. Consequently, they provide a point of departure for future theorizing about the effectiveness of persuasive health messages.

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