Abstract

Although the numerical information effects has been reported in persuasive contexts, little research has investigated how numeric information in the drug efficacy appeals may affect consumers' evaluation of DTC advertising. Based on an experiment, the current study revealed that: (a) consumers reported more positive perceived message effectiveness of and attitude toward advertising toward numeric DTC advertising; (b) when consumers were lowly numerate, the persuasive effects of numeric information was stronger. When consumers were highly numerate, however, the persuasive effects of numeric information was significantly reduced; and (c) perceived message effectiveness was found to be a valid indicator of actual DTC advertising effectiveness, by mediating between the numeric information effects and attitude toward DTC advertising. Theoretical and practical/regulatory implications of DTC advertising were discussed.

The Food and Drug Administration (FDA) began to relax the requirements of consumer advertising of prescription drugs in the late 1980s (Cox, Cox, & Mantel, 2010). Accordingly, direct-to-consumer prescription drug advertising (DTCA) expenditure has rapidly increased from $4.2 billion in 2005 (United States Government Accountability Office, 2006) to over $4.8 billion in 2008 (Nielson, 2009). Although the growth rate was relatively slow from 2009 ($4.4) through 2010 ($3.9) due to the economic recession (Kaiser Family Foundation, 2010), DTCA is still ranked as one of the major revenue sources for the pharmaceutical industry.

Consumers and patients tend to be less informed about medical treatments than their physicians or pharmacists due to the limited information accessibility. DTCA provides consumers with critical health information that they otherwise ignore or fail to receive (Calfee, 2002). Further, DTCA is expected to have influence on consumers' perceptions and behaviors (Beltramini, 2006, Lee, Salmon, & Paek, 2007). Well- informed consumers and patients may be able to play an important role in their health decision making (Calfee, 2002). In that sense, DTCA has a potential to contribute to consumer health literacy.

A substance body of research has been to understand diverse aspects of the DTCA impact on society. Some consists of nationally representative consumer surveys. The most notable examples include two surveys conducted by *FDA* itself in 1999 and 2002 (Calfee, 2002). In addition, *Prevention Magazine* and the *Kaiser Family Foundation* performed national surveys as well (Calfee, 2002). The findings of the surveys showed that over 80 percent of consumers are aware of DTC advertisements and DTCA contributes to encourage consumers to seek additional health information from various sources, such as books, friends, the Internet, the new media, and their physicians (Calfee, 2002). Eighty-one percent of consumers talked to their own doctors,

followed by pharmacists (52 percent) (Calfee, 2002). This body of research indicates generally positive consumer attitude toward DTCA.

Another line of DTCA research has focused on its contents (e.g., Bell, Kravitz, & Wilkes, 2000; Huh & Cude, 2004; Roth, 1996; & Sheehan, 2007), because public health may be sensitive to the DTCA contents. Surprisingly, however, little research has been conducted on the actual DTCA message effects on consumers' perceptions and health behaviors. Although survey analytic studies (e.g., Sumpradit, Fors, & McCormick, 2002) have reported that DTCA exposure has a significant impact on consumers' perceptions and health behaviors, an understanding of how DTCA influences consumers remains elusive.

The purpose of the current study is to investigate whether DTCA message quantification influences consumers' perceptions. Another objective is to examine the potential moderating role of consumer numeracy. Information processing literature (Bell, 1984; Baesler & Burgoon, 1994; Chang & Lee, 2010; Kazoleas, 1993; Rosenthal, 1971; Witt, 1974, 1976; Yalch & Elmore-Yalch, 1984) found that "numbers" have influence on consumers cognitive processing. However, the numerical information effects may not be always consistent across individual consumers. Consumer health literacy is varied across each consumer (Rothman et al., 2008) and therefore will be a potentially moderating factor on the DTCA message quantification effects. In the current study, *"consumer numeracy"* will be examined as a critical individual difference. Lipkus et al. (2001) suggested that methods and consequences of communicating health information tailored to consumers' level of numeracy should be examined further.

The present study attempts to address a relatively under-treated health problem among younger adults, clinical sleep disorder. According to *Centers for Disease Control and Prevention*

(CDC), although 16 percent of Georgia's residents experience persistent sleep problems, only 10 percent reported having been diagnosed with a sleep disorder (*CDC*, 2011). Among younger adult population, sleep disorder was found to be a more severe health problem. A nationally representative sample (N = 80,121) survey from institutions of higher education revealed that 25.6 percent of college students reported sleep difficulties as a serious health impediment (*American College Health Association*; *ACHA*, 2009). Undesirably, although sleep disorders should be treated properly, younger adults may tend to ascribe the reasons of the sleep illnesses to their lifestyles rather than health problems. In line with this, Wright et al. (2006) argued that early diagnosis and proper treatment of clinical illnesses is critical to the adolescents and younger adults. Once it occurs, mental-related health diseases tend to persist. As a health information source, examining the potential influence of sleep disorder DTCA on younger adults' perceptions is promising.

THEORETICAL BACKGROUND

The Effects of DTCA Message Quantification

DTCA conveys useful information of drugs and treatment options to lay consumers. After Food and Drug Administration (FDA) relaxed the requirements of DTCA in 1997, this advertising category has become more exposable to lay consumers. DTCA uses diverse types of evidence to support drugs' efficacy appeal. By nature, the evidence includes numbers, technical jargons, and graphs, etc. Nevertheless, research on how lay consumers process technical information has been ignored. DTCA readability can be a critical issue with regard to consumer health literacy. Therefore, the current study focuses on the influences of numerical data on consumers' perceptions in the sleep disorder DTCA among younger adults.

Since 1970s, readability of numerical data has been an important consideration to understand consumers' scientific writing processing. Witt (1976) noted that the level of difficulty in scientific writing has increased over time. Especially, the use of numbers in the scientific information is a widely adopted technique. Thus, readability of numeric information is an important issue for informed consumers in a technical society (Witt, 1974).

How younger adult consumers read numeric health information in DTC advertisements? Witt (1974, 1976) pointed out that factors which increase textual difficulty can be thought to decrease message comprehension and weaken consumers' ability of making a decision. In the context of DTCA, consumers frequently read numerical data and they should understand the information to make a sound health decision. Because health professionals such as physicians and pharmacists are professionally trained, there may be no problem with their ability to translate numeric data in prescription drug advertisements. Most lay consumers, however, have only limited health numeracy (Fagerlin et al., 2007). Therefore, it is not clear whether they are well-informed from numerical DTCA.

A line of study has reported more persuasive effects of statistical evidence than narrative report (Chang & Lee, 2010; and Dickson, 1982). Most previous studies of the numeric information effects, however, compared mostly statistical evidence with narrative form. No research has compared statistical data with qualifying language (e.g., "common," "rare," and "many," etc) in prescription drug advertisements, which is an intensively used technique in DTC advertisements (Cox, Cox, & Mantel, 2010; Davis, 2007).

Which approach (numeric information versus qualifying language) is more effective in DTCA? Witt (1974, 1976) demonstrated a potential effect of numerical data on consumers'

comprehension (Witt, 1974; 1976). He found that numerical data may improve people's understanding up to a point beyond which understanding declines (Witt, 1974). In a following study, he investigated the effects of quantified information in scientific writing and confirmed that message quantification affects people's problem-solving ability (Witt, 1976). Even though the investigation of a proper level of quantification goes beyond the present study's scope, without doubt the use of numerical information has been increasing.

With regard to DTCA, when the messages are presented with jargons or numerical data, consumers may not pay careful attention to read detailed medical information in it. Even, consumers may misinterpret DTA's probability words (Cox, Cox, , & Mantel, 2010). Because of this potential problem, Food and Drug Administration (FDA) suggests DTC advertisers to use "*consumer-friendly language*" (Kaphingst & DeJong, 2004; Kaphingst et al., 2004). However, determining which DTC messages are consumer-friendly is not conclusive. The FDA has no official guidelines for the use of numeric information and qualitative words such as "rare" and "common"

Because numbers reduce uncertainty than abstract language (Rosenthal, 1971), numeric information may be more credible than qualifying language. Although Witt's (1974, 1976) pointed to a curvilinear relationship between message quantification and consumers' understanding of scientific writing, practically speaking, in DTCA drug efficacy appeals numeric information may not be excessively used compared with professional-targeted drug advertising. Therefore, a more productive discussion will be on a positive association between numeric information (versus qualifying language) and consumers' appraisal of DTCA. Based on the above discussion, when comparing numeric information with qualifying language, it is possible to hypothesize the following:

H1: Compared with the use of qualifying language, numerical representation of a prescription drug's health benefits will be more persuasive, resulting in a more favorable evaluation of message effectiveness and attitudes toward the advertisement.

The Moderating Role of Consumer Numeracy

Many potential confounding factors have been reported in measuring advertising effectiveness (Grewal, Gotlieb, & Marmorstein, 1994). In order to design more effective DTCA , it is critical to identify influential moderating factors of the numeric information effects. I suggest *"consumer numeracy"* is one such factor with potential to moderate the numeric information effects. Lipkus and Peters (2009), pointed out that little research has investigated how numeracy influences information processing in health domain. By this time, empirical studies have dealt with mostly measuring adults' numeracy level (e.g., Donelle, Hoffman-Goetz, Arocha, 2007; Galestic & Farcia-Retamero, 2010; Lipkus, Samsa, & Rimer, 2001).

Numeracy is defined as "the ability to process basic probability and numerical concepts." (Peters et al., 2006, p. 407). This individual difference factor is important for consumers to comprehend and transform probability numbers in DTCA messages. Numeracy relates to consumers' performance on judgment and decision tasks (Peters et al., 2006). People differ in numerical ability (Peters et al., 2006 and Rothman et al., 2006).

Peters et al. (2006, 2007) reported that highly numerate individuals are more less susceptible to framing effects compared with less numerate individuals. That is, Peters et al. (2007) found that less-numerate consumers were influenced more by different frames of numeric information than those are more-numerate.

In a similar vein, Reyna et al. (2009) found that low numeracy distorts perceptions of risks and benefits information. They argued that low numeracy is associated with greater susceptibility to extraneous variables which do not change the objective information (Reyna et al., 2009). That is, how the information is presented is a critical factor in processing information.

As mentioned above, considering the practical level of numeric information use in DTC advertisements, basic and simple numeric information (e.g., percentage and frequency) may not lead to greater cognitive efforts to younger adults, and thereby numeric DTC advertising will be more influential to low numeric consumers vice versa. The influences of numeracy on processes such as perceptions of message effectiveness, information seeking, and interpretation are likely to vary based on situational determinants (Lipkus & Peters, 2009). For instance, the influence of numeracy may vary as a function of the task (Lipkus & Peters, 2009). Simple tasks may not vary much by numeracy. In more complex tasks, however, numeracy may play a much more important role in how it is used in health decisions (Lipkus & Peters, 2009). Further, this is consistent with dual-process models of attitude change (e.g., elaboration likelihood model; Petty & Cacioppo, 1986). Lower cognitive tendency may lead to more susceptibility to extraneous variables such as communication formats (Zhang & Buda, 1999). Attitude change of low numerate consumers may be influenced more by peripheral cues such as message format (Peters et al., 2006). The following hypothesis can be proposed.

> *H2: Numeracy will moderate the persuasive effects of numerical information in DTCA. That is, for low numerate consumers, numerical representation of a drug's health benefits will produce a more favorable evaluation of message effectiveness and more positive attitude toward advertising than the use of qualifying language*

does, whereas for high numerate consumers, the effects of numerical information will be significantly reduced.

The Mediating Role of Perceived Message Effectiveness and Attitude Toward Advertising

The present study uses "*perceived message effectiveness*" and "*attitude toward advertising*" (Dillard, Shen, & Vail, 2007) to measure the effectiveness of a sleep disorder DTC advertisement. Dillard et al. (2007) noted that there are practical reasons for seeking to explore the relationship between perceived message effectiveness and actual effects. If perceived message effectiveness is found to be a valid indicator of the actual DTCA effectiveness, then enhancing perceived message effectiveness may serve as a useful strategy in persuasive DTCA campaigns (Dillard et al., 2007). To further explore the process in which consumers form attitude toward DTCA, the following hypothesis can be proposed:

H 3: The interactive effects of numerical information and message framing on attitude toward DTCA are mediated by perceived message effectiveness.

METHOD

Design

To test the three hypotheses, I employed a 2 (type of evidence: numeric information versus qualifying language) × 2 (numeracy: high versus low) between-subjects design. Because moderate correlations among the set of dependent variables were expected, a multivariate analysis of variance (MANOVA) was used as the main method of hypothesis testing (Kim & Park, 2010). A follow-up test of univariate effects were performed for exploratory purposes.

Baron and Kenny's (1986) four-step method of confirming mediation was used to explore the third hypothesis.

Subjects and Procedure

A total of 184 college students enrolled in communication and advertising classes at a southern state university participated in return for course credit. The age ranged from 18 to 39 years and the average age was 19.9 (*SD* = 2.68). The majority (61.7) were female and Caucasian/White (79.4%), followed by Africa/American (9.4%), Hispanics (3.9%), and Asian (3.3%), etc.

Prior to the experiment, the treatment booklets were randomized and distributed. Block and Keller (1995) pointed out that various individual differences such as prior knowledge of a disease and either through direct or vicarious experience may have impact on health-related perceptions. Thus, subjects were asked to complete the prior knowledge and experience measures regarding clinical sleep disorder due to their possible influence on dependent variables (e.g., overall health status, familiarity with clinical sleep disorder, and the degree of knowledge about clinical sleep disorder, perceived importance of clinical sleep disorder, and experience of clinical sleep disorder, etc).

Subjects were presented with a sleep disorder print DTC advertisement. After exposure to the stimulus, subjects completed manipulation checks and dependent measures, and provided demographic information. It took approximately 20 min to complete the instrument. Upon completion of the instrument, subjects were thanked.

Numeracy Measure

Recently, Fagerlin et al (2007) developed the subjective numeracy scale (SNS) and Zikmund-Fisher et al. (2007) validated the measurement scale. Although objective numeracy measures have been used successfully in demonstrating consumers' numeric judgment and comprehension of numeric information, there have been concerns that research participants are not receptive to taking a mathematical test (Fagerlin et al., 2007). In Fagerlin et al.'s (2007), participants gave negative feedback about answering objective numeracy questions. This aversive aspect of objective numeracy measure may lead to lower completion rates as well as higher attrition rates for longitudinal studies (Fagerlin et al., 2007). More seriously, participants may answer randomly. Thus, Fagerlin et al. (2007) developed the subjective numeracy scale (SNS). They found that the SNS is a powerful predictor of people's ability to perform numerically intensive tasks (Fagerlin et al., 2007). I averaged across all SNS items answered and missing data were removed from the analysis. In addition, due to the varying difficulty levels and scale wording differences of each item, all items were standardized and then summed into a composite measure. For the analysis, the composite score divided into two categories using a median-split method.

Total eight items cover perceived mathematical ability and preference for presentation of statistical information (Reyna et al., 2009). Some of the questions include "*How good are you at working with percentages*," "*When people tell you the chance of something happening, do you prefer that they use words or numbers*," and "*How often do you find numerical information to be useful.*" (for more information, see Fagerlin et al. (2007). According to Zikmund-Fisher et al. (2007), the SNS responses were significantly related to numerical information processing performance relevant to medical decision making.

Dependent Measures

I measured perceived message effectiveness (Dillard et al., 2007) and attitude toward advertising (Dillard et al., 2007) as criterion variables. Perceived message effectiveness was measured by asking subjects to rate on five items which consisted of *not persuasive/persuasive, ineffective/effective, not convincing/convincing, and not compelling/compelling* on 7-point scales from 1 = *disagree strongly* to 7 = *agree strongly*.

Attitude toward an DTC advertisement was measured using *useless/useful, not beneficial/beneficial, low quality/high quality/, worthless/valuable,* and *non-informative/informative.* Subjects rated the extent to which they agreed or disagreed with these statements using 7-point scales from 1 = *disagree strongly* to 7 = *agree strongly*. The two dependent variables' Cronbach's α indices were greater than .75 (perceived message effectiveness, Cronbach's α = .92; and attitude toward an DTC advertisement, Cronbach's α = .88), which is reliable (Grewal, Gotlieb, & Marmorstein, 1994). Responses were averaged into a single index.

RESULT

Manipulation Check

To check the evidence type (numeric information versus qualifying language) manipulation, I asked subjects to rate the extent to which they agreed or disagreed with two statements using 7-point scales from 1 = *disagree strongly* to 7 = *agree strongly*. The two statements were: "*This advertisement uses specific numeric information (e.g., "45% or "1 in 4") to support its claims*," and "*This advertisement uses broad language (e.g., "many" or "common") without specific numeric information to support its claims* (reverse coded)." A composite score was derived and

used for analysis. The results indicated that subjects found a numeric DTC advertisement more numerical than its qualifying counterpart vice versa. ($t_{(1,177)}$ = 15.99, p = .000). the manipulation of evidence type was successful.

Analysis

As the 2 x 2 factorial design had multiple dependent variables measuring different facets of the overall DTCA effectiveness, multivariate analysis of variance (MANOVA) was used to test the interaction hypotheses. The MANOVA results indicate significant main effects of numerical information, but not significant interaction effects between statistical information and numeracy (see Table 1).

Hypothesis 1: The Numeric Information Main Effects.

The MANOVA results in Table 1 indicate main effects for evidence type. As hypothesized numeric information DTCA was more effective than qualifying language DTCA on perceived message effectiveness (*Ms* = 4.04 and 3.16) and attitude toward a DTCA advertisement (*Ms* = 4.10 and 3.41) (*Wilks's* □ = .880, F = 11.917, p = .000). These results demonstrated that quantitative information is generally more effective than qualifying language. Thus, Hypothesis 1 was supported.

PLACE TABLE 1 ABOUT HERE

If the evidence type had significantly differential effects on perceived message effectiveness and attitude toward advertising, it would be more appropriate to test H1 by conducting separate ANOVAs for the two dependent variables as a within-subject factor. To rule out this possibility, a three-way mixed ANOVA was designed, including evidence type and

message frame as between-subject factors and the two dependent variables as a within-subject factor.

As Table 2 shows, the two-way interaction of evidence type and the within-subject factor was not significant (*Wilks's* □ = .983, $F = 3.041$, $p = .083$). This ruled out the possibility that the evidence type might have had differential effects on the two dependent variables. Therefore, follow-up ANOVAs were not necessary.

PLACE TABLE 2 ABOUT HERE

Hypothesis 2: The Evidence Type × Numeracy Interaction Effects.

Hypotheses 2 was designed to test the interactive effects of evidence type (numerical information versus qualifying language) × subjective Numeracy (high versus low) on the effectiveness of a DTC advertisement. To test this prediction the two dependent variables, including perceived message effectiveness and attitude toward advertising, were submitted to a 2 (evidence type: numerical information versus qualifying language) × 2 (message frame: gain versus loss) between-subjects MANOVA. As Table 1 shows, the MANOVA results revealed the evidence type × subjective numeracy interaction was not significant. (*Wilks's* □= .988, $F = 1.030$, $p < .359$). Therefore, the multivariate results did not support H2.

Although the omnibus multivariate F-test was not statistically significant, support for Hypothesis 2 can be seen from the results of cell comparisons. A number of articles and method books "support the planned comparison procedure directly without the *F*-test if theoretically motivated." (Kees, 2011, p. 24). Also, Kees (2011) pointed out that it is not necessary to perform an overall omnibus *F*-test of significance prior to testing planned orthogonal comparisons,

contrasts are appropriate even though the overall *F*-test failed to reach significance. Priori predictions call for such tests (Rutherford, 2001).

Results show that there was no difference in high numerate and low numerate consumers' reported attitude toward a sleep disorder DTC advertisement (*Ms* = 4.00 and 3.4816,$p_{\text{Bonferroni}}$ = .15). However, when numeracy was low, consumers reported significantly higher attitude toward a sleep disorder DTC advertisement using numeric information (*Ms* = 4.20 and 3.33, $p_{\text{Bonferroni}}$ = .001). the pattern of results supports Hypothesis 2 for attitude toward a sleep disorder DTC advertisement but not for perceived message effectiveness. A plot of these results is shown in Figure 1.

PLACE FIGURE 1 ABOUT HERE

As in Hypothesis 1, a three-way mixed ANOVA was designed, including evidence type and subjective numeracy as between-subject factors and the two dependent variables as a within-subject factor.

As Table 2 shows, the three-way interaction of evidence type, subjective numeracy, and the within-subject factor was not significant (*Wilks's* □ = .994, *F* = 1.020, *p* = .314). This ruled out the possibility that the evidence type × subjective numeracy interaction might have had differential effects on the two dependent variables. Therefore, follow-up ANOVAs were not necessary.

Hypothesis 3: The Mediation Effect of Perceived Message Effectiveness on Attitude toward Advertising and Additional Analysis and Results

Because the interaction effects of evidence type × subjective numeracy was not statistically significant in the omnibus F-test, the mediating test for the interaction effects cannot be conducted through the Baron and Kenny's (1986) regression procedures. Nevertheless, the main purpose of the test was to further explore the process in which consumers form attitude toward DTCA. It may be informative to explore the mediating role of perceived message effectiveness between the main effects of numeric information and attitude toward DTC advertising instead. To test the possibility that the effects of evidence type on attitude toward advertising were mediated by perceived message effectiveness, I performed a series of regression tests of four requirements for confirming mediation (Baron & Kenny, 1986). I tested if (a) the evidence type × message frame interaction is significantly related to attitude toward advertising; (b) the interaction is significantly related to a potential mediator; (c) the mediator is significantly related to attitude toward advertising after the interaction was controlled; and (d) after the mediator was controlled, the interaction related significantly less to attitude toward advertising than before the mediator was controlled.

To test requirement (a) attitude toward advertising was regressed on evidence type, subjective numeracy, and the evidence type × subjective numeracy interaction. Satisfying the first requirement, attitude toward advertising is significantly related to the numeric information factor (β = -.874, p = 000). Requirement (b) was examined by regressing the potential mediator to evidence type, subjective numeracy, and their interaction. Satisfying the requirement, perceived message effectiveness (β = -.953, p = .000) is significantly related to the numeric information factor.

To test requirement (c), attitude toward advertising were regressed on the potential mediator, controlling evidence type, subjective numeracy, and their interaction. In the regression

model, perceived message effectiveness (β = .710, p = .000) is significantly related to attitude toward advertising. Therefore, perceived message effectiveness met the third requirement.

As previously noted, attitude toward advertising significantly related to the evidence type (β = -.874, p = 000)). This association dropped to non-significance (β = -.197, p = .149) when perceived message effectiveness was controlled. Sobel's (Sobel, 1982) test confirmed the reduction was significant (Z = 3.6609, p = .000), satisfying requirements (d) for perceived message effectiveness. Therefore, perceived message effectiveness met the fourth requirement.

The above four-step analysis revealed that perceived message effectiveness satisfied the four requirements for mediation. This indicated that evidence type (the numeric information effects) influenced perceived message effectiveness and variances in this mediating factor ultimately led consumers to form attitude toward advertising.

DISCUSSION

The current study focused on the role of numeric information in assessing a sleep disorder DTC advertisement. The study revealed consumers were influenced by message presentation format when they have low level of numeracy. In addition, the perceived message effectiveness mediated between the numeric information effects and attitude toward a sleep disorder DTC advertisement. Findings of the research have implications for the theory and practice of DTC advertising.

Theoretical and Practical Implications

The current study contributes to the advertising theory. Although the impact of numeric information on consumers' perceptions has been reported in cognitive psychology, the DTC

literature has ignored the message factor. The current study represents the unique empirical test of the potential effects of numeric information on the consumers' perceived message effectiveness and their attitude toward DTC advertising. The current study also revealed the role of subjective numeracy in moderating the effects of numeric information in a sleep disorder DTC advertisement, a finding that has not been reported in either the DTC or the numeracy literature. Through the contrast tests, the interaction was found to be significant even though the omnibus F-test failed to reach significance.

The current study also contributes to the practice of DTC advertising, especially for tailoring more effective DTC messages. As discussed, DTCA can provide consumers with useful health information and thereby consumers can make well-informed decisions to cope with their health problems. When considering the under-treated nature of sleep disorders among younger adults, the influence of a effective DTC advertisement will be significant. Further, the message quantification is an attractive technique because it can be used in applied setting. By designing appropriate levels of numeric information in sleep disorder DTC advertisements, DTCA can contributes to expand a drug category. The expansion of a drug category may be an important marketing goal for under-treated diseases such as sleep illnesses among younger adults. Therefore, it is critical to examine how DTCA message designers can enhance message effectiveness through tailoring message frames such as message quantification.

The current study revealed the interaction effects of numeric information and subjective numeracy. The reasons why the omnibus F-test failed to support the Hypothesis 2 can be explained in some ways. One possible explanation can be that college student samples are relatively homogeneous population in terms of cognitive ability, life style, and media uses. Especially, the current study utilized student sample from similar major domains. This may be

the cause why there was not statistically significant variations among subjects with regard to subjective numeracy. The small variation of numeracy may be an impediment for finding statistically significant results. Diverse other contexts and populations can provide richer insights for the research of numeracy and DTC advertising.

The current study found that low numerate consumers were more influenced by numeric information framing. These results are consistent with the previous numeracy studies (e.g., Peters et al., 2006, 2007; Reyna et al., 2009) in that highly numerate consumers are not easily affected by extraneous factors such as framing. Although there have been studies on message framing with gain and loss frames, little research investigated the message quantification framing in the context of DTCA. The present study encourages that future researchers can explore whether the level of message quantification in DTCA can influence consumers health-related perceptions. With regard to DTCA message contents, although there have been content analytic studies (e.g., Macias & Lewis, 2003-2004; Macias et al, 2007; and Sheehan, 2007), a particular message factor effect has been ignored.

In addition, the current study's findings were consistent with the ELM approach (Petty & Cacioppo, 1986). According to Zhang and Buda (1999), highly cognitive people were not susceptible to the message framing. As ELM proposes, highly cognitive elaboration tends to impede the peripheral message factors. Highly cognitive stimulus may be needed to persuade highly cognitive people. Likewise, highly numerate consumers may be more susceptible to highly numerate information (Lipkus & Peters, 2009). Thus, future research can explore the level of numerate information and the interaction effects with numeracy.

The key finding of this study was that numeric DTC advertising can contribute to enhance consumers' favorable evaluation of DTC advertising. Specifically, the current study revealed that the numeric information effects on attitude toward advertising were mediated by perceived message effectiveness. As Dillard, Shen, and Vail (2007) asserted, there are substantial practical reasons to identify the relationship between perceived message effectiveness and attitude toward advertising. By tailoring DTC advertising messages, message designers can contribute to enhance the DTCA campaigns. The health-communication campaigns have social value in that they can reduce under-treated social health problems such as sleep disorders. Nevertheless, under-diagnosed populations such as younger adults have been largely neglected so far. The potential role of DTCA in improving the public health invites substantial future research.

In light of the FDA's "*consumer friendly*" recommendation, the current study also provide important implications. Although the level of message difficulty has been increasing, the FDA does not has official guideline for determining which DTC contents are helpful or detrimental. The current study examined consumer numeracy as one of health literacy components. Without an understanding of consumer numeracy level, it is difficult to conclusively determine the impact of DTCA on consumers' perceptions and health behaviors. Therefore, public policy makers should understand consumers' level of numeracy and its role in comprehending health information. Such efforts will represent the first step that the public policy makers can take to ensure the success of regulations of DTCA.

It is also important to note that there is research suggesting the negative aspects of message quantification (Witt, 1974, 1976). Excessive numeric information, technical jargons, or graphs may result in lower levels of consumer comprehension of DTCA health information.

From the health promotion perspective, a main standard to evaluate the social value of DTCA health information is how well it informs balanced knowledge and helps consumers make a better health decision. More effective health communication through DTCA, therefore, have advantages for DTC advertisers, public policy executers, and consumers. Diverse aspects of health literacy, including numeracy, should be investigated for better understanding of its social impacts of DTCA.

Limitations and Suggestions for Future Research

This study has some limitations. First, the current study utilized an experimental approach. Thus, the artificiality can be a methodological limitation. However, the experimental method provides much confidence of causal relationship between independent variables and outcome variables. The trade-off between internal and external validity is not avoided easily. Second, the current study adopted subjective numeracy measure from Fagerlin et al.'s (2007) study. Although the subjective numeracy measure has its own advantages compared with objective mathematical measures, the results should be carefully interpreted. The subjective measure cannot replace the objective measures, serving as only a proxy. Third, the present study utilized college student samples. Although the younger adult populations were selected with reasonable rationales, diverse populations and contexts can provide rich insights for DTC advertisers and researchers. In addition, various health contexts can be examined further.

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APPENDIX 1

TABLE 1

MANOVA RESULTS FOR THE DEPENDENT VARIABLES

	MANOVA				
Independent variable	*Wilks's* □	*F*	*Hypothesis df*	*Error df*	*P*
Evidence Type (ET)	.880***	11.917	2	175	.000
Subjective Numeracy (SN)	.999	.085	2	175	.919
ET × SN	.988	1.030	2	175	.359

Note: *p<.05*, *p<.01, ***p<.001

APPENDIX 2

TABLE 2

Mixed ANOVA RESULTS FOR THE TWO DEPENDENT VARIABLES

	MANOVA				
Independent variable	*Wilks's* □	*F*	*Hypothesis df*	*Error df*	*P*
WS	.957***	7.923	1	176	.005
WS × Evidence Type (ET)	.983	3.041	1	176	.083
WS × Subjective Numeracy (SN)	.999	.150	1	176	.699
WS × ET × SN	.994	1.020	1	176	.314

Note: WS is a within-subjects factor including the two dependent variables. ***p<.001

APPENDIX 3

FIGURE 1

THE INTERACTION EFFECTS OF EVIDENCE TYPE × NUMERACY