The Combination Signaling Effect of Text and Image on Mobile Phone Review Helpfulness - The Moderating Effect of Signaling Environment

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This work was supported in part by the National Natural Science Foundation of China under Grant 71603151, and in part by the Major Program of National Social Science Foundation of China under Grant 18ZDA055.

ABSTRACT Consumers are increasingly using both texts and images to express their opinions about products rather than using texts alone. Generally, texts usually contain more detailed description of product attributes, contributing to the diagnosticity of reviews, whereas images are visually more attention-grabbing on the screen, contributing to the accessibility of reviews. These two types of information complement each other in influencing potential consumers’ evaluation on review helpfulness. However, extant studies mainly investigate the impact of texts and images on review helpfulness independently. Based on signaling theory and level of processing theory, this study attempts to investigate the potential interaction effect of textual signal and imagery signal instead of only examining them in isolation. Particularly, textual signal is operated as review length, while imagery signal is operated as number of pictures in a review. Furthermore, this study also examines whether these effects vary in different signaling environment that is conceptualized as the number of reviews associated with a product. By developing a Tobit regression model for 4,063 online reviews of 39 Huawei mobile phones crawled from ZOL.com, this study empirically demonstrates that review helpfulness is positively influenced by both types of signals. Interestingly, the interaction between two types of signals has a negative impact on the perception of review helpfulness. The results also reveal that the signaling environment augments the impact of textual signal but does not significantly influence the impact of imagery signal. Additionally, it is also found that the signaling environment mitigates the negative impact of the interaction between two types of signals on review helpfulness. These findings are anomalous to the established knowledge on consumer behaviors and possible explanations are presented. Based on these findings, both theoretical and practical implications for the improvement of online review mechanism are discussed.

INDEX TERMS Imagery signal, textual signal, review helpfulness, signaling environment, signaling theory, level of processing theory.

I. INTRODUCTION

The rapid development of the Internet has provided consumers with extensive opportunities to search for sufficient product information before making purchase decisions. Since the information created by consumers is perceived to be more credible and interesting than that by sellers [1], the user-generated content (UGC) in the form of online reviews has gained popularity, and consequently becomes an important resource of information for helping consumers make purchase decisions [2], [3]. However, not all online reviews are equivalent in their effects on consumer behavior. An overwhelming number of reviews varying in the value for facilitating consumers’ decision making have induced information overload and increased search costs [4], [5]. Helpful reviews contribute to well-informed decisions [4], and maximization of customer satisfaction [6]. Therefore, it is essential to recognize the factors influencing online review helpfulness, which can help practitioners improve their online review mechanisms and assist consumers in making better decisions.

Quality signaling provides us an insight to diagnose review helpfulness. A variety of signals embedded in the online reviews can be used by readers to judge which one may be helpful for evaluating product quality. Within a specific
review, textual signal and imagery signal are the most representative among the numerous signals. Most of the studies have concentrated on how textual signals influence its perceived helpfulness, such as review depth, review uncertainty, review readability, review emotions, review sentiment, product quality relatedness [4], [5], [7]–[14]. Few studies have also considered the impact of imagery signals such as reviewer’s profile image [15]. Additionally, extant studies have also adopted sentiment mining techniques to quantify the sentiment contained in reviews and then examine its effect on the perceived helpfulness of reviews [5], [12], [14]. While extant studies might have pushed forward our knowledge of the antecedents of review helpfulness, most of them treated review text and image independently. However, the forms of communication have extended beyond text or image to text-image owing to the flourishing growth of information technology. More consumers tend to submit online reviews in the form of a combination of images and texts, namely image-text reviews. Within the text-intensive online review websites, the presence of visual information can increase the salience of an online review [15], attract readers’ attention and increase their motivation to read review texts [16]. Academic researchers have also realized that simply examining textual content without considering simultaneously imagery content is insufficient for explaining the helpfulness of a review [8]. This is because that multiple signals (i.e., text and image) might influence consumer behavior interactively and simultaneously rather than acting alone.

Additionally, in the process of decisions making, consumers are faced with not only diversified review content formats but also different volume of online customer reviews. Popular products usually receive more feedback, and the reviews associated with those products are increasing cumulatively with time passing [4]. Therefore, consumers usually encounter hundreds or even thousands of customer reviews during purchase decision making, and these numerous reviews produce a highly competitive signaling environment [5], [17]. According to the level of processing (LOP) theory, the amount of incoming information affects the level of information processing of individuals [18]. Different types of information might vary in the degrees of cognitive information processing ability consumption [19]. This implies that the signaling environment might affect whether a specific type of signal embedded in a review is perceived to be helpful or helpless. Existing studies on review helpfulness implicitly assumed that individuals possess a sufficient cognitive ability to process online product reviews. However, the cognitive ability of an individual is restricted by increased amount of information. In this case, examining the role of the signaling environment can better understand the mechanisms of how people process the types of information in the e-commerce context.

Based on signaling theory and LOP theory, this study attempts to address the above issues from the perspective of signal transmission. The objectives of this study are summarized as followed:

- To identity the influences of textual signal and imagery signal on review helpfulness.
- To examine the interaction effect between textual signal and imagery signal on review helpfulness.
- To investigate the moderating effect of the signaling environment on the relationship between different signals and review helpfulness.

Online reviews of mobile phones are selected as data source in this study, and the reasons lie in three aspects. First, mobile phone is one of the most popular products among Chinese consumers. It is reported that the number of mobile phone users in China reached 108.68 million in 2019. As a result, investigating the helpfulness of mobile phone reviews is expected to make a significant contribution in improving the design of review system of mobile phones and then facilitating consumers’ purchase decisions. Second, mobile phone is commonly considered a high-involvement product that is at a relatively high price. Purchase decisions of high-involvement products often involve much cognitive process and information gathering. Therefore, consumers tend to collect all available information such as online reviews before buying a mobile phone. In other words, online reviews are especially important for mobile phone purchase decision. In general, it is suitable to select mobile phones as our research objectives. Ultimately, 4,063 online reviews of mobile phones are used to investigate review helpfulness in this study.

II. THEORETICAL BACKGROUND
A. SIGNALLING THEORY
Information asymmetry exists between buyers and sellers in the market transaction, since different parties often gain different amount of information regarding a specific product [17], [20]. Generally, sellers are aware of essential information about products, but consumers may not be informed fully about such information. Signaling theory provides a framework to understand how signals are used to convey information from one party to another for the effective exchange or purchase. To reduce the perceived risks on products, consumers often seek relevant cues/signals to infer potential quality of a product [21], as signals disclose the object-related messages that can assist consumers in making better decisions. Signaling has become a widely accepted strategy to reduce information asymmetry.

Signaling theory has been adopted to explain how signals influence consumers’ perception, intention and behavior, and domain-specific signals have been recognized in extant studies [22]–[27]. Spence [28] argues that the essence of signaling theory lies in analyzing various types of signals and the situations where they are applied. In the context of online shopping, to facilitate the product learning processes of consumers, online retailers encourage their consumers to deliver product recommendation information through online reviews in the forms of text description or/and image presentation.

1 https://www.iimedia.cn/c1061/68332.html
As a result, textual and imagery review have become the major types of information on the online shopping websites. In this regard, this study recognizes two types of signals embedded in online reviews, i.e., textual signal and imagery signal, and aims to investigate their influence on review helpfulness.

As a signal must exist in a specific environment [28], it is important to figure out the effect of signaling environment in the process of signal transmission. Some studies have found that the signaling environment influences the degree to which the signal reduces information asymmetry [29], [30]. For instance, the value of signaling diminishes when the signaling environment becomes noisy [31], [32]. Lester et al. [30] examine this issue by considering the effect of environmental munificence, complexity, and dynamism on the signaling process. Although no empirical evidence of moderation is found in the context of IPO, their opinions deserve further attention in other contexts of signaling.

Based on signaling theory, this study attempts to explain why different reviews contribute to different degrees of helpfulness and examines how signals act in the process of evaluating the helpfulness of a review. Textual and imagery signals are investigated in the online review context. Textual signal is operated as the length of a review, whereas imagery signal is operated as the number of pictures in an online review. The signaling environment is operated as the total number of reviews obtained from a specific product [5]. This study investigates the effect of different types of signals on review helpfulness, and the interaction effect between two types of signals are also investigated since receivers simultaneously consider multiple signals available during decision-making [33]. Furthermore, the moderating effect of the signaling environment on the relationship between different signals and review helpfulness is examined.

**B. LOP THEORY**

When reading the online reviews of a specific product, consumers receive not only lots of information but also different types of information (e.g., text, image, text-image and so forth). Numerous reviews with varied presentation forms produce a highly competitive signaling environment where reviews compete with each other for obtaining consumers’ attention. Therefore, it comes to the question that how consumers process different types of information when encountering various reviews.

LOP theory provides a paradigm to understand how people process different types of information from the perspective of cognitive effort consumption. According to LOP theory, people perform different levels of mental encoding on the information presented to them, ranging from “shallow” sensory encoding to “deep” semantic encoding [19]. “Sensory encoding” is the information encoding process of analyzing sensory or physical features, such as brightness, loudness, visibility, spelling, lines and angles. “Semantic encoding” is the information encoding process of the extraction of meaning and pattern recognition [18]. For instance, when seeing the word “apple”, people only realize its pronunciation and spelling at sensory encoding level, whereas they normally interpret the word “apple” as a kind of delicious fruit that is good for our health at semantic encoding level. Compared with sensory encoding, semantic encoding implies greater depth of information processing, and hence might require a higher cognitive capacity of an individual.

Information encoding ability of individuals is affected by external stimuli [34]. On the one hand, information type influences the level of information processing. Imagery information usually evokes sensory mental encoding, whereas textual information usually evokes semantic mental encoding [18], [35], [36]. On the other hand, the amount of information also has an influence on the level of information processing by restricting individuals’ cognitive ability [18]. Higher information redundancy can lead to lower cognitive processing ability [37]. In this regard, individuals process information at a “shallow” sensory encoding stage [34]. When faced with a small amount of information, people possess a sufficient information processing ability. As a result, people tend to process information at the semantic encoding level [18].

**III. RESEARCH MODEL AND HYPOTHESES**

With the development of information communication technology (ICT), online review sites offer their users opportunities to generate content in diverse formats. By analyzing the presentation formats of UGC on online review websites, we recognize two typical signals contained in the online review, namely textual signal and imagery signal. Review length is selected as textual signal since longer reviews are more likely to contain more detailed information related to a product. Review pictures are the most salient visual information in UGC. Therefore, we identify the number of pictures in a review as the imagery signal influencing the perceived helpfulness of a review, since product-related pictures not only attract readers but also reveal product information in a more intuitive and vivid way. More recently, UGC in the form of text-with-picture is becoming prevalent among consumers. As a result, this study also focuses on the interplay between textual signal and imagery signal.

Abundant online reviews may also add noise to a signaling environment where readers have to spend more efforts in information filtering. This study intends to reveal the underlying mechanism on how the signaling environment influences the relationship between signals and review helpfulness. The research model is shown in Fig 1.

The hypotheses development is shown in the following sections.

**A. TEXTUAL SIGNAL**

Review length is a reflection of the size of the review text on the screen, and it is believed a longer review can usually catch readers’ attention at first sight [38]. Review length is regarded as a typical representative textual signal and has been frequently studied in previous literature [39], [40].
In general, the extent to which a review contributes to purchase decisions depends on the amount of product-related information available in the review [41]. Longer reviews commonly cover detailed information on how and where a product was purchased and even the consumption experiences on how it was used in a specific context [6], [42], which contributes to reduce the perceived uncertainty of product quality. Additionally, previous study has also found that the expertise of the recommending peers significantly affects purchase decisions of potential consumers [43]. Experienced reviewers often possess deeper insight and knowledge about the product that is being reviewed, which is often reflected in the length of their reviews [41]. As a result, a lengthy text might increase the perception of higher credibility of information resource. In this way, longer reviews can significantly enhance consumer’s confidence in decision-making [42], [44]. In short, a longer review might be perceived to be more comprehensive and more diagnostic than a shorter one. On this basis, we hypothesize:

H1: Review length will be associated with review helpfulness. The longer reviews will be perceived to be more helpful than the shorter reviews.

B. IMAGERY SIGNAL

A review picture is visually more attention-grabbing on the screen and not easily be overlooked. The colored pictures, therefore, are selected as an important imagery signal in this study. Visual information exerts its function from two aspects. On the one hand, vivid pictures can elicit affective responses by serving as its decorative function (aesthetic simulation) [45], [46]. The aesthetic appeal of imagery information adds to enjoyment [47], [48], and retains readers’ attention on a focal event [49]. On the other hand, pictures can intuitively display the external attributes (e.g., color, size, shape and so forth) of the product, known as informational function. Consumers are often in short of sensory experience about products as they are spatially separated from sellers in the online shopping context. Pictures represent the analog of real objects [50]. There is a high level of physical similarity between pictures and real objects [51], helping consumers shape a mental image of the product. Therefore, by serving its information function, pictures can help consumers enhance their comprehension of the product. Pictures were first applied to the advertising industry and their positive effects on advertising performance have been demonstrated. Most advertisers frequently depend on pictorial advertisement to promote their products to the public and motivate consumers to purchase a product [49]. In the online review context, pictures not only draw more attention to a review by performing decorative function, but also enhance consumers’ comprehension and knowledge about the product by performing informational function. On this basis, we hypothesize:

H2: Number of review pictures will be associated with review helpfulness. The reviews with more pictures will perceived to be more helpful than the review with fewer pictures.

C. INTERPLAY BETWEEN TEXTUAL SIGNAL AND IMAGERY SIGNAL

Lately, the form of a combination of text and image has gained an increasing popularity in online reviews [52]. Diversified forms of information presentation can increase the diagnosticity of information. Thus, not only do consumers use image and text in conjunction to present their opinions, but their purchase behaviors are also simultaneously affected by the two types of information. By considering text information alone, we fail to illustrate the combined signaling effects on review helpfulness.
The effect of review length on review helpfulness might interact with the number of review pictures. More cognitive efforts and higher information processing ability are required when an individual read a long review [15]. It is difficult for consumers to read a full lengthy text during the decision-making process. A picture can reduce the difficulty of reading and motivate the intention to continue reading by aesthetic appeal [15], [46]. In addition, when reading a long review, consumers are more likely to take a quick glance at it and not fully catch the embedded information [15]. Importantly, pictures display physical product features in a succinct and intuitive way. The existence of pictures might help consumers comprehensively master certain product information that might be ignored in a lengthy text. As a result, the effect of pictures might be stronger for the longer reviews owing to their high difficulty in reading. On this basis, we hypothesize:

H3: The effect of review length on review helpfulness will be moderated by the number of review pictures. This relationship will be magnified by increasing the number of review pictures.

D. THE MODERATING EFFECT OF THE SIGNALING ENVIRONMENT

The amount of pending information might influence how individuals process it. Small amount of online reviews will not ask for too much information processing capacity of individuals, which means, individuals might possess a relatively higher cognitive information processing ability [19], [53]. In this regard, individuals tend to process information with a rational, objective and in-depth analysis [18]. People are more likely to process the online reviews at a “deeper” semantic encoding level where textual information is recognized better [35]. Nonetheless, more online reviews decrease individuals’ cognitive ability to process information [37]. Hence, people might process information in a superficial, subjective and intuitive manner, and information processing is expected to reach the “shallow” sensory encoding level in which imagery information is superior to textual information in the easiness of learning [18]. In brief, the more online reviews consumers are confronted with, the higher tendency they will have to process information from a deep encoding to a shallow encoding owing to the constriction of the cognitive processing ability. On this basis, we hypothesize:

H4: The effect of textual signal on review helpfulness will be moderated by the signaling environment. As the number of online reviews increases, this relationship will be mitigated.

H5: The effect of imagery signal on review helpfulness will be moderated by the signaling environment. As the number of online reviews increases, this relationship will be magnified.

When exposed to extensive reviews, consumers might be overwhelmed with substantial information, and this is accompanied by the increase of search costs. Consumers tend to depend more on the distinctive characteristics to narrow down reviews at a first glance so as to effectively reduce search costs [41]. An image-text review can be of help, because the highly competitive signaling environment makes it more eye-catching. With the addition of informativeness of image-text reviews, the likelihood of them being evaluated as helpful might be higher than others. On this basis, we hypothesize:

H6: The interactive effect between textual signal and imagery signal on review helpfulness will be moderated by the signaling environment. As the number of online reviews increases, this relationship will be augmented.

The research framework is shown in Figure 1.

IV. RESEARCH METHODS

A. DATA COLLECTION AND DATA PROCESSING

ZOL.com is selected as the data source. ZOL.com has been tapped by scholars for data collection [54], as it is a professional online review website about digital devices, where its users can discover, evaluate and review digital products. The dataset analyzed in this study is collected from Huawei phone. This is because Huawei phone holds the highest market shares in China, and thus there are more online consumer reviews. Using “Huawei” as the keyword, we found 39 Huawei mobile phones on ZOL.com, and then crawl all online reviews for each product by Octopus Collector, a professional data collection software. After deleting the reviews with no review rating or the reviews with neither text or image, 4,063 online reviews are obtained. For each review, review text, review numerical rating, reviewer expertise, review date, and the number of helpful votes are obtained. The number of pictures of each review is collected manually. The total number of the online reviews per product is also collected. Figure 2 illustrates an online review posted on ZOL.com, which has been translated from Chinese to English.

B. VARIABLE OPERATIONALIZATION

The operationalization of research variables is summarized in Table 1. Review helpfulness, the dependent variable, is determined by the total number of helpful votes for the online review. To measure the review length, NLPIR, the most popular Chinese lexical analysis system is used to conduct the word segmentation [55], [56]. Next, review length is measured by the number of words in a review after punctuation and stop words are deleted. Review pictures are operated as the total number of pictures in an online review. The signaling environment, serving as a moderator, is measured by the number of cumulative reviews for a product. Previous studies also found that review rating, reviewer expertise, and review posting date affect the perceptions of review helpfulness [5]. Hence, this study considers these three variables as the control variables. Review rating is operationalized by the numerical rating from 1 (negative) to 10 (positive). Reviewer expertise is a dummy variable, denoting 1 if the reviewer is an elite member and 0 otherwise. Review date is measured by days elapsed after the review is posted.
V. EMPIRICAL ANALYSIS

A. MODEL SPECIFICATION

The Tobit regression is employed to analyze the relationship between different types of signals and review helpfulness, and to examine the moderating effect of the signaling environment. Tobit regression is chosen for two main reasons. Firstly, the distribution of dependent variable, review helpfulness, seems to be left-censored. Additional computational problems must be considered in order to analyze a linear regression with the existence of censored data. However, applying OLS regression to the censored dependent variable does not calculate the consistent parameter estimates [8], [57]. Secondly, Tobit regression model is able to address the selection bias inherent in this study [58]. A certain review may receive zero response to the helpful votes, indicating that the review is perceived to be unhelpful. Although OLS regression depicts the relationship between variables, it treats a zero value as a missing value [59]. However, the zero helpful votes actually indicate that people perceive the review unhelpful. Inconsistent with OLS regression, Tobit model identifies zero helpful votes as a real value and can help solve the problem of section bias [58]. Owing to the censored dependent variable and selection bias, this study attempts to apply the Tobit model to investigate how different antecedents influence review helpfulness and to measure the fit with the values of Log Likelihood and pseudo $R^2$ [60].

B. RESULTS

Table 2 reports the descriptive statistics, including max, min, mean and standard deviation for all variables. The correlation analysis of the research variables was conducted and shown in Table 3. As is illustrated in Table 3, both review length and number of pictures are positively correlated with review helpfulness, initially confirming the rationality of our hypothesis. The regression analysis was conducted to examine the research hypotheses in the next section.

For avoiding potential multicollinearity among variables, all variables were mean centred before the interaction terms are created [61]. The estimated results are shown in Table 4. Graphical representation for these results is also illustrated in Figure 3. According to model 1, review length was significantly and positively related to review helpfulness. It indicated that longer reviews were perceived to be more helpful, which supported H1. Model 2 showed that the number of pictures in the review had a positive effect on review helpfulness. In line with H2, more pictures increased the perceived helpfulness of a review. To investigate the interactive effect of textual signal and imagery signal, review length, number of pictures and their interaction were included in model 3. The estimated results suggested that the interaction effect between review length and the number of pictures was negatively related to review helpfulness, suggesting that as the number of review pictures increased, the perceived helpfulness of...
TABLE 2. Description statistics of key variables (N=4063).

| Variables      | Min | Max   | Mean  | SD    |
|----------------|-----|-------|-------|-------|
| Helpfulness    | 0   | 5,253 | 75.211| 227.827|
| Length         | 0   | 2,555 | 82.989| 164.749|
| PictureNum     | 0   | 47    | 0.949 | 2.617 |
| ReviewNum      | 8   | 423   | 180.766| 164.749|
| Rating         | 1   | 10    | 8.482 | 2.026 |
| ReviewerExpertise | 0 | 1   | 0.091 | 0.288 |
| ReviewDate     | 5   | 1,384 | 444.690| 325.734|

TABLE 3. Pearson’s correlation matrix of research variables.

| Variable         | 1    | 2    | 3    | 4    | 5    | 6    | 7    |
|------------------|------|------|------|------|------|------|------|
| 1. Helpfulness   | 1    |      |      |      |      |      |      |
| 2. Length        | 0.375*** | 1    |      |      |      |      |      |
| 3. PictureNum    | 0.350*** | -0.147*** | 1 |      |      |      |      |
| 4. ReviewNum     | 0.003 | 0.038** | -0.032** | 1 |      |      |      |
| 5. Rating        | -0.133*** | 0.128*** | 0.016 | -0.083*** | 1 |      |      |
| 6. ReviewerExpertise | 0.354*** | 0.668*** | -0.194*** | -0.063*** | -0.067*** | 1 |      |
| 7. ReviewDate    | 0.120*** | -0.016 | -0.126*** | 0.155*** | -0.388*** | -0.088*** | 1 |

*p < 0.1; **p < 0.05; ***p < 0.01.

TABLE 4. Results of robust tobit regression.

| Variable                | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 |
|-------------------------|---------|---------|---------|---------|---------|---------|
| Length                  | 0.298*** (0.067) | 0.564*** (0.070) | 0.325*** (0.025) | 0.583*** (0.068) |         |         |
| PictureNum              | 0.253*** (0.070) | 0.397*** (0.076) | 0.254*** (0.070) | 0.413*** (0.076) |         |         |
| Length*PictureNum       | -0.084*** (0.011) | -0.088*** (0.009) |         |         |         |         |
| ReviewNum*Length        | 0.124*** (0.022) |         |         |         |         |         |
| ReviewNum*PictureNum    | 0.016 (0.015) |         |         |         |         |         |
| ReviewNum*Length*PictureNum | 0.008*** (0.002) |         |         |         |         |         |
| ReviewNum               | -0.023 (0.019) | -0.027 (0.026) | -0.056*** (0.021) |         |         |         |
| Rating                  | -0.142*** (0.018) | -0.157*** (0.018) | -0.137*** (0.018) | -0.145*** (0.020) | -0.161*** (0.018) | -0.140*** (0.018) |
| ReviewerExpertise       | 0.279*** (0.046) | 0.331*** (0.044) | 0.018 (0.057) | 0.278*** (0.026) | 0.328*** (0.044) | 0.358*** (0.057) |
| ReviewDate              | 0.322*** (0.017) | 0.330*** (0.018) | 0.348*** (0.019) | 0.330*** (0.021) | 0.334*** (0.019) | 0.358*** (0.019) |
| Pseudo R²               | 0.102 | 0.100 | 0.127 | 0.105 | 0.101 | 0.129 |
| Log Likelihood          | -4936.42 | -4946.06 | -4796.41 | -4918.70 | -4943.61 | -4785.03 |
| p > χ²                  | <0.000 | <0.000 | <0.000 | <0.000 | <0.000 | <0.000 |

the longer review would decrease. Thus, H3 was reversely supported.

Next, the moderating effect of the signaling environment was examined. In model 4, the number of the reviews for a product was found to positively influence the effect of review length on review helpfulness. This implied that in the signaling environment consisting of abundant reviews, the positive effect of review length on review helpfulness...
was augmented. Therefore, H4 was reversely supported. In model 5, the signaling environment did not significantly moderate the relationship between the number of pictures and review helpfulness, and thus H5 was refused. In addition, it was also found that the signaling environment could reduce the interaction effect between review length and review pictures. As a result, H6 was reversely supported.

With regard to the control variables, review rating was negatively related to review helpfulness, indicating that the reviews with lower ratings were evaluated as more helpful. Both reviewer expertise and review date positively influenced review helpfulness. Hence, the review written by an individual with higher expertise was considered as more helpful, and the review posted earlier was more likely to obtain more helpful votes.

VI. DISCUSSION
Empirical evidence showed that both textual signal and imagery signal positively affect review helpfulness, which is in consistent with the findings from existing studies on the antecedents of review helpfulness [8], [39]. It is also found that increasing online reviews augment the impact of textual signal on review helpfulness, but not imagery signal. This is supported by the verbal superiority effect, stating that the text exerts stronger effect on purchase intention than the picture under certain contexts [35], [62]. The online reviews analyzed in this study are gathered from mobile phone that is regarded as a search product. For most search products, imagery information fails to help consumer extract the meaning of an incoming event since it only conveys information on the appearance of the product (e.g., color, shape and size). However, consumers may focus primarily on the intrinsic attributes (e.g., camera, battery, screen, performance, system and quality) that make the quality of search products more explicit and specific. Such attributes-related messages are generally only obtained from texts, not by images. Therefore, when encountering a great number of online reviews across the search products, consumers tend to rely more on the texts rather than the images so as to quickly master essential information.

With regard to the interaction between textual and imagery signal, the negative interaction effect on review helpfulness is found in this study. This is contrary to the commonly accepted notion in existing literature, which highlighted that text-with-image UGC is superior to text-only in increasing purchase intention [16]. The possible explanation for this anomalous result is that a vast amount of information presented in various formats lead to information overload, especially when the meaning expressed by different types of information is equivalent [35]. Instead of leading to higher diagnosticity and persuasiveness, more pictures that cannot add anything new to obtain intrinsic information of the product do increase the burdens of information processing to consumers. Consequently, an image-text review is not always perceived as helpful since information conveyed by images can also be available in texts, leading to increased costs of information processing.

It is also found that the negative interaction effect is mitigated in the signaling environment where the total number of reviews for a product increases. The accessibility-diagnosticity model posits that information acceptance depends on both information accessibility and diagnosticity [63]. Messages that arouse consumers’ greater attention are not necessarily perceived to be more diagnostic [38]. Although a combination of text and image might not generate higher level of diagnosticity, it attracts greater attention and evokes more interest in reading the review especially when numerous reviews exist. In other words, the highly competitive signaling environment might increase...
the opportunity of a salient image-text review being voted by increasing its accessibility.

Considering control variable, reviews with a lower rating have a higher tendency to obtain more helpful votes. Because the negative reviews imply potential losses, and in turn are more likely to be highly valued by consumers. For this reason, a negative review is evaluated to be more helpful. Furthermore, the review provided by the reviewer with higher expertise increases the perception of review helpfulness, since an experienced reviewer often has a deeper understanding of the product. Additionally, as the reviews posted earlier have enough time to obtain others’ evaluation, they are expected to accumulate more helpful votes.

VII. CONCLUSION

Although online consumer reviews have become an important resource of information for helping consumers make purchase decisions [2], [3], not all online reviews are equivalent in their helpfulness for consumers decision making. Based on signaling theory, this study discusses how textual signal and imagery signal enhance the perceived helpfulness of reviews interactively, and the moderating role of the signaling environment is investigated. Essentially, this study finds the interaction between textual and imagery signal negatively influences review helpfulness. In addition, the signaling environment, as an important moderator, influences the effect of signal on review helpfulness. Research results make a significant contribution to practical and academic domain.

The theoretical implications of this study are two-fold. Firstly, different from the existing literature that usually assumed review texts and images are independent of each other [8], the present study showed that the interplay between texts and images negatively influences review helpfulness. This result indicates the interactive effect of multiple signals should be taken into account in explaining consumers’ behavior. This paper, thus, pushes the frontiers of knowledge on review helpfulness by validating the combined signaling effect of texts and images on review helpfulness. Secondly, unlike extant studies that investigated consumers behavior without the consideration of information environment [64], [65], this study found that the impact of different information types on consumers’ perception of review helpfulness varies in different environments consisting of varying number of reviews. This suggests the amount of incoming information is a crucial determinant of consumers’ behavior. This study, therefore, assists researchers in achieving a deeper understanding of the patterns of individuals’ information processing when they are faced with different volumes of online reviews.

This paper yields some contributions for practitioners. An insight is provided for online retailers on guiding consumers to write an online review so that readers could evaluate it as helpful. First, our results illustrate that an image-text review is perceived as less helpful. Therefore, online retailers have to reconsider the practice of rewarding their users for “writing a lengthy review with more than 100 words, and uploading more than 3 contextual pictures at the same time!” as excessive pictures may bring burdens to consumers if the imagery information does not add anything new to help them gain product information. Instead, consumers should be encouraged to express their opinions in the form of either pure-text or pure-image.

Second, online retailers should locate online reviews under the consideration of the total number of reviews related to a certain product, since our results indicate that the effects of different types of signals vary as the number of reviews changes. Particularly, if a product receives hundreds of reviews, online retailers are suggested to put the longer reviews at the top of the page in order to reduce the search costs and cognitive efforts of consumers.

Finally, online retailers often hire reviewers to write positive reviews or manipulate users to delete negative reviews for increasing product sales. However, the results of this study show that negative reviews are considered more helpful for purchase decision making. Accordingly, online retailers should reconsider the effectiveness of such practical behaviors since too many positive reviews may not be of benefit of decision making.

This study still has some limitations. Firstly, the data in this study comes from an electronic product review website that is regarded as a platform for search products. Thus, the results should be carefully generalized to other settings. In order to generalize our results, it is necessary to examine other categories of products (e.g., experience products and credibility products) in future research. Secondly, the same signal might engender different responses from different receivers, determined by receiver’s expertise and engagement [22]. Future studies could investigate how receiver’s characteristics influence signal processing by experiments or questionnaires. Finally, more qualitative signals should be recognized for better explaining how a review is perceived to be helpful, such as review readability, review reliability, review enjoyment and so forth.

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