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Xuecong Lu
McMaster University, lux95@mcmaster.ca

Milena Head
McMaster University, headm@mcmaster.ca

Junyi Yang
McMaster University, yangj263@mcmaster.ca

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Understanding Online Review Helpfulness: A Color Theory Perspective

Xuecong Lu

DeGroote School of Business
McMaster University
Hamilton, Canada
lux95@mcmaster.ca

Milena Head

DeGroote School of Business
McMaster University
Hamilton, Canada
headm@mcmaster.ca

Junyi Yang

DeGroote School of Business
McMaster University
Hamilton, Canada
yangj263@mcmaster.ca

ABSTRACT

Although extant literature has investigated the helpfulness of online reviews, much of this research has focused on investigating the textual feature of online reviews, while omitting other potential determinants of helpfulness such as the image feature of online reviews. In this study, we examine the following research questions (RQ): RQ1: How will review image features (i.e., colorfulness and color harmony) influence review helpfulness? And RQ2: How will review text features (i.e., sentiment and complexity) and visual features (i.e., colorfulness and color harmony) interactively influence helpfulness? Our preliminary findings suggest that both colorfulness and color harmony of review image have positive impacts on review helpfulness, and that review sentiment has moderating impacts on the above relationships.

Keywords

Review helpfulness, colorfulness, color harmony, review sentiment, review complexity.

1. INTRODUCTION

Online reviews, particularly helpful online reviews, play an essential role in influencing customers' purchase decisions and promoting overall sales in e-commerce platforms. Following previous studies (Mudambi & Schuff, 2010; Yin et al., 2016), we define review helpfulness as the extent to which a customer-generated seller evaluation is perceived by other consumers to facilitate their purchase decision process. A recent report shows that 90% of buyers consider online reviews when making their purchasing decisions, and 78% of people trust online reviews as much as a recommendation from a family member or friend (Georgiev, 2021). As such, e-commerce sites compete for consumers' attention by identifying and presenting helpful reviews enabled via a helpfulness voting mechanism. A typical and often cited example is Amazon which was reported to gain an additional \$2.7 billion in annual revenues by its online review system and the helpfulness vote mechanism (Spool, 2009). Given that helpful reviews are valuable to both customers and e-commerce platforms, a better understanding of the antecedents for review

helpfulness offers clear benefits to review writers and online vendors.

Although extant literature has investigated the helpfulness of online reviews, much of this research has focused on investigating the textual feature of online reviews, while omitting other potential determinants of helpfulness such as the image feature of online reviews. Multimedia content such as images enable users to display a broad spectrum of cognition and sentiments in their content, improving reviewer readers' online experience. Drawing on color theory (Agoston, 2013), we propose two color concepts related to image, including colorfulness and color harmony which may influence review helpfulness. In addition, we expect that the color characteristics of review images can serve as an environmental context which further interact with emotional (i.e. sentiment) and cognitive (i.e., complexity) characteristics of review text on review helpfulness. Specifically, we examine the following research questions (RQ):

RQ1: How will review image features (i.e., colorfulness and color harmony) influence review helpfulness?

RQ2: How will review text features (i.e., sentiment and complexity) and visual features (i.e., colorfulness and color harmony) interactively influence helpfulness?

This paper proceeds as follows. Section 2 provides a brief literature review focusing on antecedents of review helpfulness and color theory. Section 3 develops our research model and hypotheses. Section 4 describes the method and the preliminary results. We conclude and discuss our contributions and managerial implications in Section 5.

2. LITERATURE REVIEW AND THEORY

2.1 Antecedents toward review helpfulness

Sizable research attention has been given to review helpfulness, though largely from review (content) and reviewer (source) perspectives. Previous research has shown that review helpfulness is influenced by cognitive factors (e.g., complexity) and emotional factors (sentiment, extremity) of review text (Choi & Leon, 2020; Srivastava & Kalro, 2019; Yin et al., 2016). Additionally, review helpfulness is also influenced by reviewer characteristics

such as expertise, identity, and rank and reputation. However, there is one area that has not received the same attention: review images. For instance, Amazon.com has listed a separate section to display reviews with images, which suggests the value of review images for review readers. The past few years have witnessed a shift from text-centric to visual-oriented experience in online platforms. While many studies have examined the determinants that drive review helpfulness from a user-generated content (UGC) perspective, most of these studies focus on the text content of online reviews, leaving the role of image content largely unexplored.

2.2 Color theory

A notable feature to invoke users' attitude is color. Previous studies have shown that color can influence perceived trustworthiness, users' loyalty, and purchase intention (Cyr et al., 2010; Dey et al., 2020; Hall & Hanna, 2004). Existing studies mainly examine specific colors (e. g. blue) that influence users' perception toward a user interface. In our focal study, enabled by an image analytics technique, we extract two main features from the review image, namely colorfulness and color harmony. The colorfulness of a picture is highly dependent on the distribution of colors. For example, an image with more different colors and more equal distribution of these different colors appears more colorful. Colorfulness can evoke both an emotional response of arousal and a cognitive response of complexity, which may interact with the emotional and cognitive component from the text content of an online review to influence review helpfulness. In color theory, color harmony refers to the property of aesthetically pleasing color combinations. Color harmony is associated with a relaxing, comfortable, and peaceful state where individuals enjoy the aesthetics of harmonious color combination. Taken together, colorfulness and color harmony of a review image may serve as a contextual factor that interacts with the emotional and cognitive components of review text to determine review helpfulness

3. RESEARCH HYPOTHESES

In the focal study, drawing on color theory, we further investigate direct effects of review image features on review helpfulness and interactive effects of review text features (i.e., sentiment and complexity) and review image features (i.e., colorfulness and color harmony) on review helpfulness, as shown in figure 1. We focus on positive sentiment in the focal study, since positive sentiment is associated with broadened mindset, which facilitates review readers to consider both text and image components of the review. The hypotheses are presented as below.

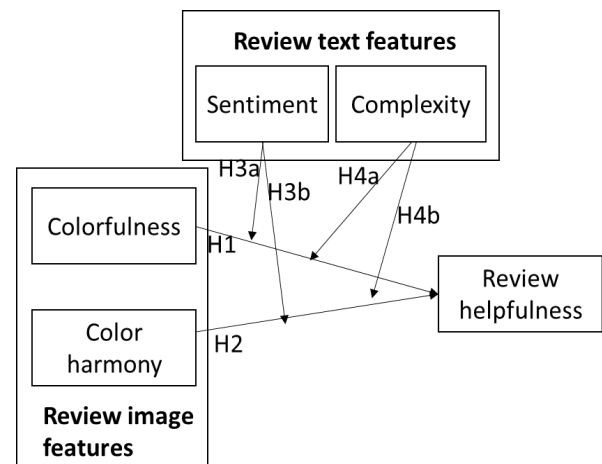


Figure 1. Research model

H1: Colorfulness of review image is positively associated with review helpfulness.

H2: Color harmony of review image is positively associated with review helpfulness.

H3a: Sentiment of review text negatively moderates the relationship between colorfulness of review image and review helpfulness.

H3b: Review text complexity negatively moderates the relationship between review colorfulness of review image and review helpfulness.

H4a: Sentiment of review text positively moderates the relationship between color harmony of review image and review helpfulness.

H4b: Review text complexity negatively moderates the relationship between color harmony of review image and review helpfulness.

4. METHODOLOGY

4.1 Data Source

We collected data from luxury beauty products (e.g., luxury fragrance, luxury makeup) in Amazon in the past five years using our self-designed python program. We selected luxury products, since they are mostly experience goods that are more dependent on online reviews. Since review image features are important variables for our study, we only included reviews with uploaded images in our dataset with a sample size of 1041.

4.2 Operationalization of Variables

Review helpfulness: the number of helpfulness votes received for a review, as in previous research

Review score: the review score provided by the review writer.

Sentiment of review text: We generated sentiment scores (using Python) by analyzing the online reviews through sentiment analysis and opinion mining algorithms using a

dictionary of positive emotion English sentiment words (Liu, 2010). This dictionary associates a score to each review on the emotions expressed within the words of that texts. A larger score indicates stronger positive sentiment. The final score ranges from -1 to 1, with -1 indicating a weak positive sentiment and 1 indicating a strong positive sentiment.

Review text complexity is measured as the average automated readability index (ARI) of the chosen Amazon reviews. The automated readability index is applied to quantify textual complexity, as in previous studies with user generated content (Johnson et al., 2015). A higher ARI score represents higher complexity of the review. The equation for computing the complexity is as follows:

$$\text{ARI} = 4.71 * (\# \text{ Characters} / \# \text{ Words}) + 0.5 * (\# \text{ Words} / \# \text{ Sentences}) - 21.43$$

Colorfulness of review image: Adopting colorfulness measures in previous study (Kim & Kim 2019), we first computed the differences between each color channel of red, green, and blue in each pixel. Their mean and standard deviation across all pixels in a photo were used to calculate the colorfulness of the photo. C is the returned colorfulness matrix.

$$\begin{aligned} C &= \sigma_{rgb} + 0.3\mu_{rgb} \\ \sigma_{rgb} &= \sqrt{\sigma_{rg}^2 + \sigma_{yb}^2} \\ \mu_{rgb} &= \sqrt{\mu_{rg}^2 + \mu_{yb}^2} \\ rg &= R - B \\ yb &= \frac{1}{2}(R + G) - B \end{aligned}$$

where σ and μ are the standard deviation and the mean value of the pixel cloud.

Color harmony of review image: This study takes the approach from previous study (Kim & Kim 2019) and computes color harmony as the internal angle on the color wheel between the two colors used the most in an image, as illustrated in figure 2. First, the color space of an image was transformed into HSV (hue, saturation, value) that represents the kind (hue), richness (saturation), and brightness (value) of the color. Next, a histogram of hue value was generated and smoothed through Kernel Density Estimation. The top two frequent colors were identified as the highest and second highest peaks of the smoothed curve (see figure 2). Finally, the two colors were mapped on the color wheel and the internal angle between them (θ) was denoted as the color harmony of the image. The color harmony of each review was measured as the mean color harmony of all images uploaded in one review.

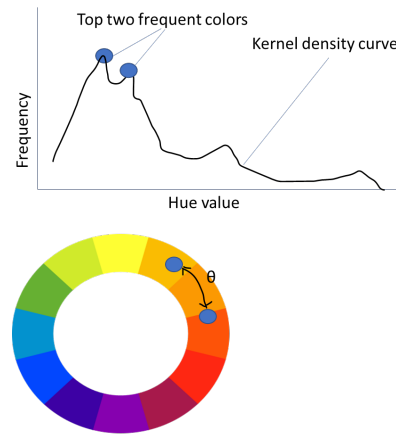


Figure 2. Color detection and internal angle calculation on the color wheel (Adapted from Kim & Kim 2019)

4.3 Data Analysis Approach

Our dependent variable is a count of the helpfulness vote for the Amazon reviews. Traditional multiple linear regression models would be biased and inconsistent when dependent variable is measured as count variables. The dependent variable exhibits overdispersion, as evidenced by the fact that the variance of the dependent variable is substantially larger than its mean. To accommodate for the overdispersion of dependent variable, a negative binomial model is preferred and used in this research.

4.4 Preliminary results

Table 1 and Table 2 present descriptive statistics and correlations for the variables used in the analysis. The highest correlation is 0.31, suggesting that these variables are statistically distinguishable. Due to the skewness of review complexity, colorfulness of review image, and color harmony of review image, we log-transformed all these variables. We applied a stepwise regression approach. The control variables are tested in model 1, followed by the test of main effects in model 2, and moderation effects in model 3. The Log-likelihood value increased from model 1 to model 3 and the AIC and BIC value decreased from model 1 to model 3, indicating improved model fit with the addition of main effects and moderating effects.

In model 2 (main effects) of negative binomial regression, the coefficient of colorfulness of review image ($\beta = 0.136$) is positive and statistically significant ($p < 0.01$), thus supporting Hypothesis 1. In model 2, the coefficient of review text complexity is significant and positive ($p < 0.05$), and thus supporting Hypothesis 2. In model 3 (moderation effects), the interaction between colorfulness of review image and sentiment is negative and significant ($\beta = -1.036$, $p < 0.05$), confirming Hypothesis 3a. The interaction term between color harmony of review image and review sentiment is positive and significant ($\beta = 2.966$, $p < 0.01$), supporting Hypothesis 4a. Lastly, the interaction

between review text complexity and color properties of review image is insignificant.

Variable	Mean	Std. dev.	Min.	Max.
Review helpfulness	26.56	70.50	6	922
Review score	3.63	1.71	1	5
Sentiment of review text	0.17	0.25	-1	1
Review text complexity	10.16	4.19	-8.66	47.98
Colorfulness of review image	37.94	16.28	0	92.23
Color harmony of review image	61.10	12.24	17.70	114.87

Table 1. Descriptive Statistics (N = 1041)

Variable	1	2	3	4	5	6
1.Review helpfulness	1					
2.Review score	-0.04	1				
3.Sentiment of review	-0.04	0.50*	1			
4.Review complexity	0.02	0.01	-0.09*	1		
5.Colorfulness	0.03	0.10*	0.02	0.01	1	
6.Color harmony	0.05	0.10*	0.10*	0.02	0.31*	1

Table 2. Inter-correlations (* p < 0.05; ** p < 0.01)

5. CONCLUSION

In this study, we integrated online word of mouth and color theory research to provide novel insights regarding impacts of colorfulness and color harmony of images on review helpfulness. Our preliminary findings suggest that both colorfulness and color harmony of review image have positive impacts on review helpfulness. In addition, review sentiment has a negative moderating impact on the relationship between colorfulness of review image and review helpfulness, but a positive moderating impact on the relationship between color harmony of review image and review helpfulness.

This study has made both theoretical and practical contributions. Theoretically, we show that the textual and image components of online reviews can interactively influence its helpfulness rating. Drawing on color theory, we investigated the image components of colorfulness and color harmony which can affect review readers’ emotional and cognitive responses. Our research complements the existing online review literature by proposing the importance of the color characteristics of review images. Practically, sites such as Amazon.com elicit a helpfulness vote mechanism on customer reviews to increase site “stickiness”. The results of this study can be used to develop guidelines for creating more helpful online reviews. For example, our results imply that online retailers should consider an integrative guideline for writing online review with uploaded images.

Future steps of this research-in-progress paper will be performed in the following ways. Firstly, the research model can be extended to include other antecedents of review helpfulness as control variables. For example, reviewer characteristics have also been shown to influence review helpfulness. Secondly, we will explore different types of online products, such as search versus experience products, given the different nature of these products. Lastly, we will examine additional features of review image to provide additional insights on the interactive effects of review text features and review image features.

REFERENCES

1. Agoston, G. A. (2013). *Color theory and its application in art and design*. Vol. 19. Springer.
2. Choi, H. S., & Leon, S. (2020). An empirical investigation of online review helpfulness: A big data perspective. *Decision Support Systems*, 139(September), 113403. <https://doi.org/10.1016/j.dss.2020.113403>
3. Cyr, D., Head, M., & Larios, H. (2010). Colour appeal in website design within and across cultures: A multi-method evaluation. *International Journal of Human Computer Studies*, 68(1–2), 1–21. <https://doi.org/10.1016/j.ijhcs.2009.08.005>
4. Dey, D., Habibovic, A., Pflieger, B., Martens, M., & Terken, J. (2020). Color and Animation Preferences for a Light Band eHMI in Interactions between Automated Vehicles and Pedestrians. *Conference on Human Factors in Computing Systems - Proceedings, April*. <https://doi.org/10.1145/3313831.3376325>
5. Georgiev, D. (2021). *Latest Online Reviews Statistics In 2020 – The Impact On Business*. Review 42. <https://review42.com/resources/online-reviews-statistics/>
6. Hall, R. H., & Hanna, P. (2004). The impact of web page text-background colour combinations on readability, retention, aesthetics and behavioural intention. *Behaviour and Information Technology*, 23(3), 183–195.

- <https://doi.org/10.1080/01449290410001669932>
7. Johnson, S. L., Safadi, H., & Faraj, S. (2015). The Emergence of Online Community Leadership. *Information System Research*, 26(1), 165–187.
 8. Kim, J. H., & Kim, Y. (2019). Instagram user characteristics and the color of their photos: Colorfulness, color diversity, and color harmony. *Information Processing and Management*, 56(4), 1494–1505.
<https://doi.org/10.1016/j.ipm.2018.10.018>
 9. Liu, B. (2010). Sentiment analysis and subjectivity. In *Handbook of natural language processing* (pp. 627–666).
 10. Mudambi, S. M., & Schuff, D. (2010). What Makes a Helpful Online Review? A Study of Customer Reviews on Amazon.com. *MIS Quarterly*, 34(1), 185–200.
<https://doi.org/10.1017/CBO9781107415324.004>
 11. Yin, D., Mitra, S., Zhang, H., & Yin, D. (2016). Research Note—When Do Consumers Value Positive vs. Negative Reviews? An Empirical Investigation of Confirmation Bias in Online Word of Mouth. *Information Systems Research*, 27(1), 131–144.
<https://doi.org/10.1287/isre.2015.0617>
 12. Spool, J. M. (2009). *The Magic Behind Amazon's 2.7 Billion Dollar Question*. Centre *UIE.
<https://articles.uie.com/magicbehindamazon/>
 13. Srivastava, V., & Kalro, A. D. (2019). Enhancing the Helpfulness of Online Consumer Reviews: The Role of Latent (Content) Factors. *Journal of Interactive Marketing*, 48, 33–50.
<https://doi.org/10.1016/j.intmar.2018.12.003>