


Warm color–romance association: Evidence of click-through rate from digital reading platform

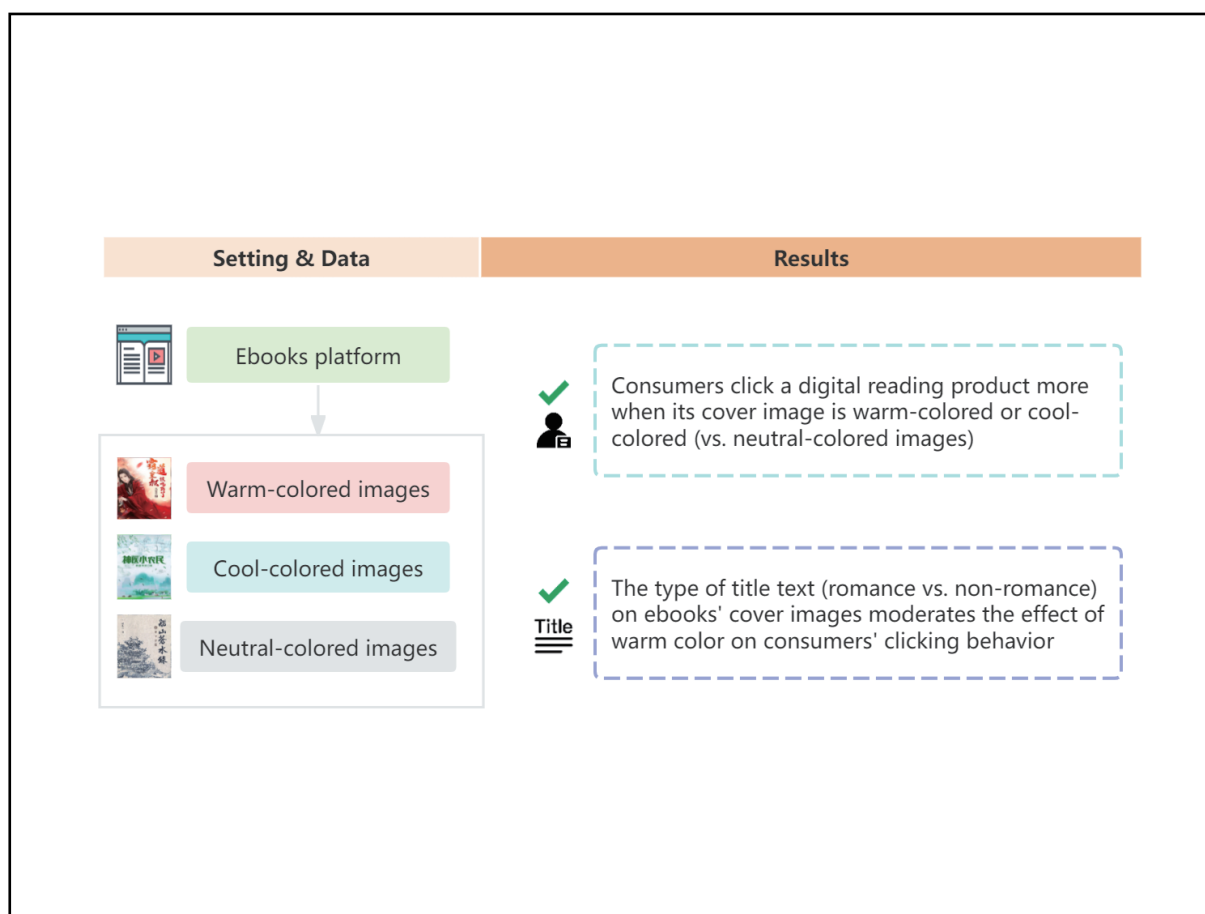
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Graphical abstract



The research data and results of this study.


Public summary

- This study coded the hue composition of polychromatic pictures using a new method that enables the examination of warm and cool colors' role in e-commerce.
- This research highlights how color impacts the clicking-through of digital content products in e-commerce.
- This research demonstrates how warm colors convey semantic meaning in the context of digital reading and how they enrich theme-based semantic interpretations.

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Abstract: Color, classified as warm and cool colors, impacts consumers' product selection. How the warm and cool dimensions of colors in polychromatic pictures impact consumers' behavior in e-commerce platforms remains unexplored. This research examines the influences of warm and cool color combinations on consumers' liking using polychromatic stimuli in a digital reading context using empirical evidence from over 200000 exposures to 423 books. As a result, warm and cool colors (vs. neutral colors) can enhance the click-through rate, and the romance theme of novels can enhance the positive effect to consumers of warm colors (vs. neutral colors). This research extends the findings using monochromatic stimuli and indicates a theme-based visual-product attribute congruence that enhances consumers' trial-reading choice on the digital reading platform.

Keywords: visual marketing; digital content; warm colors; cool colors; processing fluency; clicking-through rate

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1 Introduction

Vision is the primary sense for consumers in online contexts. Picture color, composition style, and constituent elements are identified as effective visual components. By effectively arranging visual components, visual marketing is vital in e-commerce to significantly influence consumers' attention, attitudes, purchase, and consumption^[1,2]. As consumers have become adapted to interface-mediated purchases after decades of e-commerce development and still lack touch and feel options, designers have attempted to arrange visual elements effectively^[3], convey the intended meaning accurately, and reduce consumers' perceived uncertainty in online shopping. Existing research has explored how pricing strategies, product appearance, product categories, and online user-generated content (e.g., reviews) drive consumers to read about a product, compare it with alternatives, shape trust in the product quality and purchase intention, and pay for the product. In their research, physical products (e.g., cups, toys, and clothes) were presented to depict the products' appearance in reality. As digital products created USD 294 billion in market revenue in 2021 worldwide, according to Statista (<https://www.statista.com>), digital product representations, free from the constraints of physical appearance, allow designers' discretion in the creation and drive their seeking for instruments to leverage the clicking-through rate and purchase in competition.

Among visual elements, colors are fundamental for human perceptual processing and shape the first impression of products. Psychological and cognitive neuroscience research identifies the interrelationship between color and the emotional system at the semantic level. Color semantics suggest how

colors are associated with emotional descriptors^[4]. Prior research has explored the association of color attributes (e.g., hue and saturation) and their semantic meanings using monochromatic stimuli through lab experiments and surveys^[5]. One popular color category differentiates colors into warm and cool colors, and their semantic meanings are examined using representative hues such as red and blue. Numerous studies use monochromatic stimuli of limited hues (e.g., red and blue). However, in marketing practice, rich colors combine in polychromatic images. How warm and cool colors play a role in polychromatic images on visual interfaces and how they are perceived, interpreted, and consequentially influence consumers' clicking-through remain unexplored. Our research explores the two questions and enriches the literature on visual marketing and digital products as follows.

First, we coded the hue composition of polychromatic pictures using a new method that enables the examination of warm and cool colors' role in e-commerce. Most existing studies on hues have followed the warm and cool hues classification proposed in 1981^[6] and adopted typical colors (i.e., red and blue) as experimental stimuli to identify their impact. For example, elderly residents of nursing homes prefer blue wallpapers in their bedrooms and red wallpapers in their activity rooms. The color preference for interior space matches the arousal level of the expected activities in the space. Donators who view the blue (vs. red) background of the webpage show a high (vs. low) level of patronage intention, as they regard color as a sign of high quality (vs. monetary sacrifice)^[5]. When colors are organized to be polychromatic images, the findings on color semantics and their impact need empirical examinations. The measurement of hue composition in past research uses an average value of pixels,

which is problematic^[7] because the mean value may mistakenly refer to a hue greatly biased from the overall hue perception. Our research adopts an innovative method to validate the hue measurement. The method based on clustering divides images into color segmentation and enables the coding of hues.

Second, the study focuses on the effect of warm and cool colors on digital product trial uses. Digital products can be experienced online before consumer purchase, which is different from physical products experienced exclusively offline, usually after purchase. E-books, as a category of electronic products, have been extensively studied in academic research. When competing with many book options, a well-designed cover image largely determines whether consumers click on an e-book and start their trial reading. The trial as the milestone toward payment provides rich information for consumers' judgment. Digital product consumption allows us to distinguish the product information-seeking stage from the rest and identify the impact of visual appeals on trial reading and enables us to reveal how cover image raises consumers' interest in their product-seeking stage and leads to purchases.

Third, we explore the semantic meaning of warm colors in the context of digital reading and enrich theme-based semantic interpretations. The interpretation of color semantics largely depends on its context. Reasonable interpretations of the color semantic meaning become conventions, which are accepted by an increasing population of viewers and accumulate to be the meta-cognition between color and context. This research investigates how congruence between warm color and romance themes influences the clicking-through rate and reveals the mechanism of the romance–warm color association. By doing so, we establish the meta-cognition between color and book content theme and contribute to the optimization of image design in e-commerce.

2 Literature review and hypothesis development

2.1 The effectiveness of warm and cool colors

Much of the extant color research focuses on hue^[8], a key parameter with lightness and saturation measuring color appearance. Hues are perceived as 12 major colors in HSV color models^[9]. The colors are determined by the spectral composition of the light source^[5]. Hues affect human emotions and behavior^[10], including consumers' perception of destinations, purchase willingness, and click behavior.

Research has shown that using the average value to measure hue is problematic because it can mistakenly lead viewers to assume that an image is a solid color when it contains a variety of tones. Kobayashi, a representative color theorist, proposed color classification methods through more than ten years of color psychophysical experiments. He divided hues into cool colors and warm colors^[6]. Black, white, and gray, defined as neutral colors, are not cool or warm colors. Warm and cool color classification has been widely studied in marketing research.

Warm and cool colors trigger emotional responses and affect decision-making. When consumers were in stores, cooler environments were more likely to increase purchase

intentions than warmer environments^[11]. Warm colors significantly enhance user satisfaction in activity rooms, while cool colors are more effective in increasing satisfaction levels in bedrooms^[12]. The warm background of an online website relative to a cool background made consumers respond significantly negatively to high prices.

2.2 Color in digital reading products

Digital content uses multimedia, big data, and various network technologies to integrate, distribute, sell, and serve information resources. The digital content industry covers books, videos, music, games, and other applications, with digital reading being one of the areas of great interest^[13]. To judge digital reading products, consumers must first experience them. Different from physical products that are purchased first according to price and appearance and then experienced^[14], digital reading products provide trial reading before purchase decisions^[15]. How the digital platform attracts consumers to click through, start trial reading, and further evaluate the value of the book content is worth studying.

Digital reading products are displayed on web pages in the form of cover images and textual titles, enabling consumers to browse and select from the available options. Generating visual appeal is the first step in marketing, and image is crucial in shaping consumers' memories and attitudes^[16]. The color of cover images facilitates consumers to quickly evaluate a product. Color-in-context theory states that the effect of color on consumer attitudes and behaviors depends on the context in which it is presented. Neutral colors are indicated to be less conducive to consumers remembering images accurately than the presence of color^[17]. Neutral-colored environments are less attractive than warm and cool colors environments, and neutral-colored products attract consumers' less visual attention and cause less aesthetic satisfaction. In particular, warm colors are more effective in triggering clicking in gameplay than neutral colors^[18]. In line with the advantage of warm and cold colors (vs. neutral colors), we propose that polychromatic images characterized as warm or cool colors cause more consumer clicking-throughs than neutral-colored images.

H1: Consumers click a digital reading product more when its cover image is warm-colored or cool-colored (vs. neutral-colored images).

H1a: Consumers click a digital reading product more when its cover image is warm-colored than when it is neutral-colored.

H1b: Consumers click more for a digital reading product when its cover image is cool-colored than when it is neutral-colored.

2.3 The interaction of book-type text and warm (vs. cool) image colors

As consumers are exposed to information overload when searching for products online, the congruency between the product category and its visual appearance can help consumers verify whether the product is desired^[19]. Previous research on visual information–product attribute congruency indicates that congruency helps convey messages to consumers effectively^[8]. For example, blue packaging leads consumers to believe that the product is healthier. The high relevance of

color and product attributes helps consumers to evaluate the product positively. When consumers perceive that visual stimuli align with product attributes, they experience heightened processing fluency and demonstrate favorable attitudes toward the product^[20]. The literature depicts product attributes using product categories such as fashion (vs. classical) products, healthy (vs. indulgent) food, and the primary function of a product. The theme, as the key attribute of digital content, indicates how a digital product serves the needs and demands of readers and deserves attention.

The study of color and text message congruency focuses on color semantics. Monochromatic colors carry universal semantic meaning for humans. For example, red symbolizes passion, white symbolizes purity, black usually represents high quality and strength, and yellow conveys a sense of harmony. The semantics of polychromatic stimuli are discussed in terms of warm and cool colors. The congruency of warm and cool colors with emotional expression can enhance the emotions conveyed. For example, the congruency of cool colors with sad emotions leads to an enhanced sense of sadness^[21]. In our context, the title text on the cover image defines the core theme of the digital reading product, while color plays a key role in reinforcing this thematic coherence.

On the one hand, romance is the most popular theme of fiction. Romance novels are a multibillion-dollar industry and the most popular category in e-books. In daily life, “love” and “warmth” are closely related. People feel warmer when they feel love. Experiments show that certain emotional experiences make people feel warmer or cooler^[22]. When people perceive being physically cool, they seek psychological warmth by watching romantic movies^[23].

On the other hand, hue and emotion are closely linked. Warm colors will bring people a “warm” feeling as the stimulation of love. Cool and warm colors affect people’s perception of environmental thermal conditions in the absence of external physical thermal stimulation. The perceived temperature of hot beverages in warm color containers was higher than that in cool color containers. Warm colors in

stores induce consumers to perceive warmth^[24]. This phenomenon can be explained by embodied cognition, where people’s physiological experience in warm conditions activates psychological sensations, leading to the perception of warmth from the heart^[25]. When this cognition is established, psychological sensations can be activated when physical stimuli are absent. After color evokes consumers’ physiological thermal sensation, consumers will adjust their decisions accordingly. For example, dressing in warm colors can amplify the perceived enthusiasm of employees, thereby promoting customer consumption. Romance–warm color congruency can improve consumers’ processing fluency. Exposed to the images of color-theme congruency, consumers will be confident about their choice^[26, 27], and their clicking-through will be enhanced. In light of the preceding studies, the following hypothesis is formulated.

H2: The type of title text (romance vs. non-romance) on digital reading products’ cover images moderates the effect of warm color on consumers’ clicking behavior.

Fig. 1 shows the conceptual framework of this study.

3 Methodology and sample

3.1 Empirical setting

We collected e-book trial reading data from a well-known e-book reading platform in China. To better conduct this study, we set up a “random recommendation” channel during the experiment, and the random and singular nature of this channel was effective in reducing the impact between multiple images. A book will be pushed randomly after users enter this channel, and the book cover image and title will be presented to users. The book cover image occupies a large proportion visually, as shown in Fig. 2. If users are interested in the book, they can choose to click on the book cover to enter the detailed introduction page of the book to obtain information such as the introduction and book chapter titles. If not interested, they will slide down the page to pick the next recommended book.

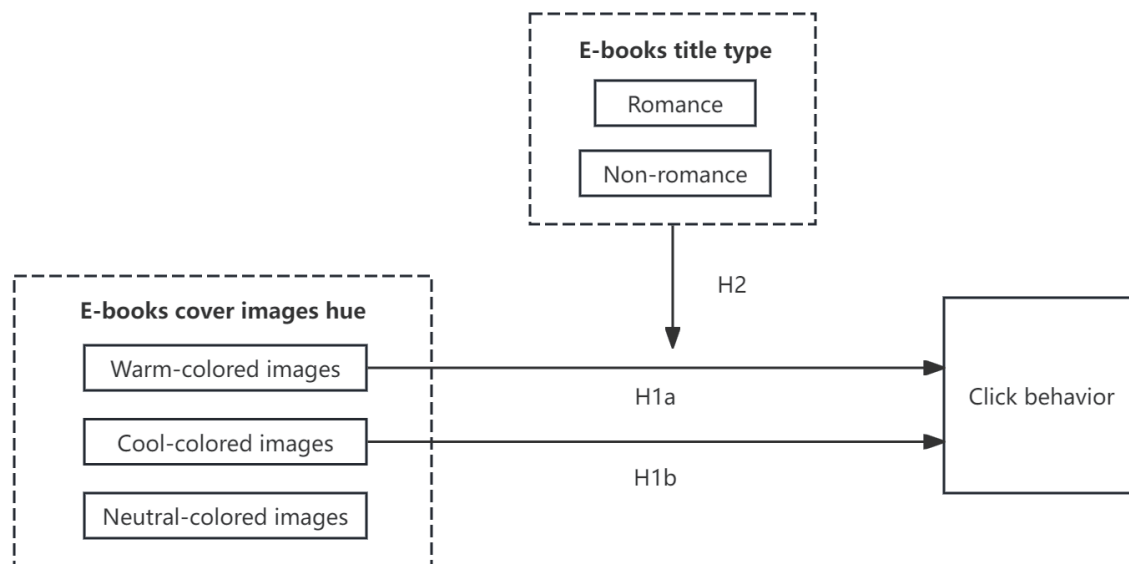


Fig. 1. Conceptual framework.



Fig. 2. How book covers are presented on the platform. From top to bottom: ① Color information means the color that people can see in the cover picture; ② the title can be seen in the cover picture and below the picture; ③ the author's name represents the author of this e-book; ④ type and like represent the type of e-book and how many times this book has been liked.

3.2 Data processing method

The research data were collected from one of the world's leading digital reading platforms established in September 2008. This reading platform has over 140 million active users monthly, providing reading services for users in more than 150 countries and regions around the world. We collected the cover images, book titles, book type labels, book exposures, book clicks, author information, and the number of likes of 423 books with more exposure between 2020-08-01 and 2021-09-01 according to the unique ID.

First, we extracted basic color information, such as average saturation and lightness, color contrast, hue count, average hue value, and color density, from e-book cover images by computer tools. The average saturation and lightness represent the intensity and brightness of images, respectively. Contrast is obtained by converting the image to HSL colors and then considering only pixels with a saturation of $S > 0.2$ and a lightness of $0.15 < L < 0.8$ and calculating the maximum arc length on the hue wheel of the effective pixel. Hue count calculates the number of effective hues based on the HSV color space excluding black and white gray, selecting pixels with saturation $S > 0.2$ and brightness $0.15 < V < 0.95$,

which represents the perceived complexity of the image. The average hue value is calculated from the mean H in HSV. HVC counting is obtained by converting the image to HVC hue space and then calculating the color density.

Second, we measured the balance of the image by the mass center, which is obtained by converting the color image to grayscale and calculating the mass center of the converted image using the intensity of each pixel. Then, we also consider other elements in the picture. The variable "Anyperson" represents the number of people in each image. The image and title relevance variables take the values 0, 1, and 2, with 0 representing no relevance, 1 representing some relevance, and 2 representing high relevance between image and title information. These two variables were labeled by multiple graduate students for each image separately and finally obtained by counting the plural. All of the above are control variables.

Finally, we use the open-source online tool "Image Color Summarizer", which comes from Canada's Michael Smith Genome Sciences Centre, to extract the information and proportions of the top five colors that people perceive when they see each image. After eliminating the neutral colors, we further determine whether the five groups of colors in each image belong to different color wheels based on the color

circle information of the HSV color space. The hue characteristics of the HSV color space depend on the composition of the light source spectrum, and the value range of angular measurement is 0° to 360° . Hue is divided into 12 colors at intervals of 30° in the HSV hue circle. The cool and warm hues are divided by a straight line between 90° and 270° , 0° – 90° and 270° – 360° are warm colors, and 90° – 270° is a cool color. We calculate the ratio of warm colors, cool colors, and neutral colors in each image. If the proportion of cool colors is 0 and the proportion of warm colors is nonzero, the image is marked as a warm-colored image. If the proportion of warm colors is 0 and the proportion of cool colors is nonzero, the image is marked as a cool-colored image. If the ratio of both cool and warm colors is not 0 and the difference between the two ratios is more than 10%, those with warm colors that account for more than 10% of cool colors are marked as warm-colored cover images, and those with cool colors that account for 10% more than warm colors are marked as cool-colored cover images. If the proportion of both cool and warm colors in an image is 0, the image is marked as a neutral-colored image. The image data that do not belong to the above cases are removed before regression analysis is performed. For example, if the cover image has more blue, green, and other cool colors, the image will be marked as cool-colored, such as in Fig. 3, and if the cover image has more red, yellow, and other warm colors, the image will be marked

as warm-colored, such as in Fig. 4. After labeling by this method, the results of manual labeling by multiple people and computer labeling are compared to demonstrate the robustness of the classification results.

3.3 Model-free evidence

To adequately characterize the raw data, we report model-free evidence. Overall, 193 romance novels and 230 non-romance novels were identified after classification. The average brightness of all images is 0.64, the average saturation is 0.31, the average contrast is 0.75, the average number of book likes is 15774.46, and the average number of author followers is 6635.58. There are 181 male frequency tag books and 242 female frequency tag books. The average CTR (click-through rate) is 0.09; see Table 1 for more detailed description statistics. The average brightness of romance books is lower but the average saturation is greater than in non-romance books. See Table 2 for the detailed color attribute information on the covers of romance books and non-romance books. There was no covariance between the tested variables.

Whether romance novels or non-romance novels, most of the cover colors are warmer, and the covers of romance novels are warmer than those of non-romance novels. See Fig. 5 for the distribution of cool and warm covers. The color distribution for romantic novel and non-romantic novel cover images is shown in Fig. 6.



Fig. 3. Example of cool-colored e-book cover images.



Fig. 4. Example of warm-colored e-book cover images.

Table 1. Descriptive statistics.

Variable	Min	Max	Mean	Std.
Cool-colored cover	0.00	1.00	0.21	0.41
Warm-colored cover	0.00	1.00	0.73	0.44
Romance novels	0.00	1.00	0.46	0.50
Hue count	0.00	13.00	3.68	2.25
HVC counting	0.01	0.66	0.34	0.11
Average hue value	0.00	237.81	130.65	57.40
Average saturation value	0.00	0.92	0.31	0.18
Average lightness value	0.09	0.99	0.64	0.25
Color contrast	0.00	1.57	0.75	0.62
X_MassCenter	34.04	34.53	3.12	10.22
Y_MassCenter	19.75	24.32	0.24	4.65
Anyperson	0.00	1.00	0.80	0.40
Covertitlecor	0.00	2.00	1.27	0.76
Book likes	101.00	697000.00	15774.46	47641.32
Author fans	107.00	328000.00	6635.58	20365.75
For men or women	0.00	1.00	0.43	0.50
CTR	0.00	0.45	0.09	0.05

Table 2. The differences between romance novels and non-romance novels.

	Romance novels		Non-romance novels		<i>t</i>	<i>p</i> (two-tailed)
	Means	Std.	Means	Std.		
Saturation	33.77%	17.50%	27.91%	18.65%	3.329	0.001
Value	54.48%	23.06%	76.16%	20.72%	−10.179	0.000
Red	16.45	23.38	21.93	27.45	−2.189	0.029
Orange	21.83	27.32	20.11	27.98	0.638	0.524
Yellow	3.27	9.97	5.12	15.04	−1.461	0.145
Yellow–orange	0.78	4.94	1.40	6.78	−1.084	0.279
Green	0.68	3.88	0.24	2.00	1.514	0.131
Cyan–green	0.15	2.29	0.89	4.47	−2.066	0.040
Cyan	2.08	7.60	1.67	8.21	0.533	0.594
Blue–cyan	6.14	13.93	5.47	17.39	0.443	0.658
Blue	3.48	12.31	2.98	11.78	0.429	0.668
Violet	1.80	6.53	1.32	6.08	0.785	0.433
Magenta	0.52	3.09	1.37	6.27	−1.719	0.087
Violet–red	2.05	7.85	5.13	12.47	−2.972	0.003

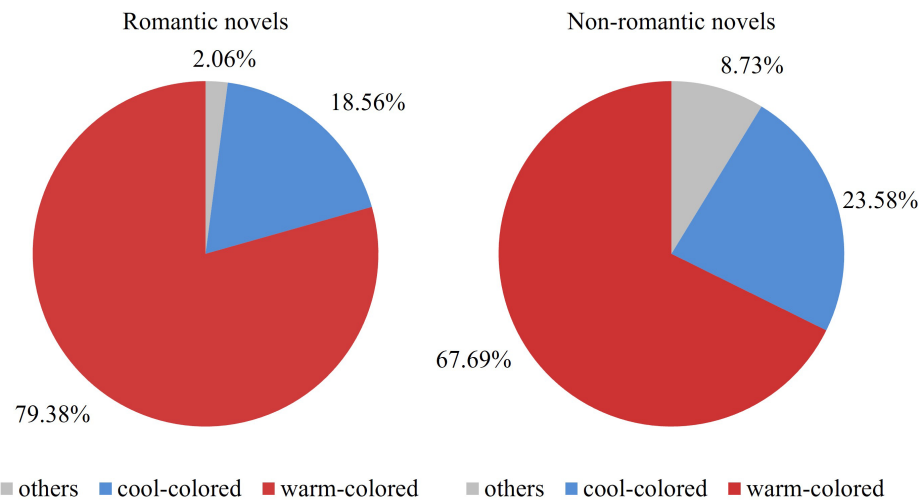


Fig. 5. Percentage of covers' color for romantic novels and non-romantic novels.

4 Results and discussion

4.1 Research model

First, through linear regression analysis, the influence of book cover images' hue on book CTR was studied. For e-book k , the likelihood that a user will click after seeing the cover is:

$$\begin{aligned} \text{CTR}_k = & \alpha + \beta \text{Romance}_k + \gamma \text{Cool}_k + \delta \text{Warm}_k + \\ & \varepsilon \text{Othercolorattributes}_k + \theta \text{Symmetryattributes}_k + \\ & \sigma \text{Anyperson}_k + \vartheta \text{Covertitlecor}_k + \mu \text{Bookinforattributes}_k + \varepsilon_k. \end{aligned} \quad (1)$$

Here, Romance is a dummy variable that takes the value 1

when the book type of e-book k is a romance novel. Cool and Warm are also dummy variables. When the cover image of e-book k is marked as cool-colored, the value of Cool is 1, and the value of Warm is 0. When the cover image is marked as warm-colored, the value of Cool is 0, and the value of Warm is 1. The coefficient ε controls the influence of other color attributes of the image, the coefficient θ controls the influence of the symmetry attribute of the image, the parameter σ is used to capture the influence of the person appearing in the cover image, the coefficient ϑ is used to capture the influence of the matching of the cover title, and the coefficient μ is used to control other book information, such as the number of books likes and the number of author fans.

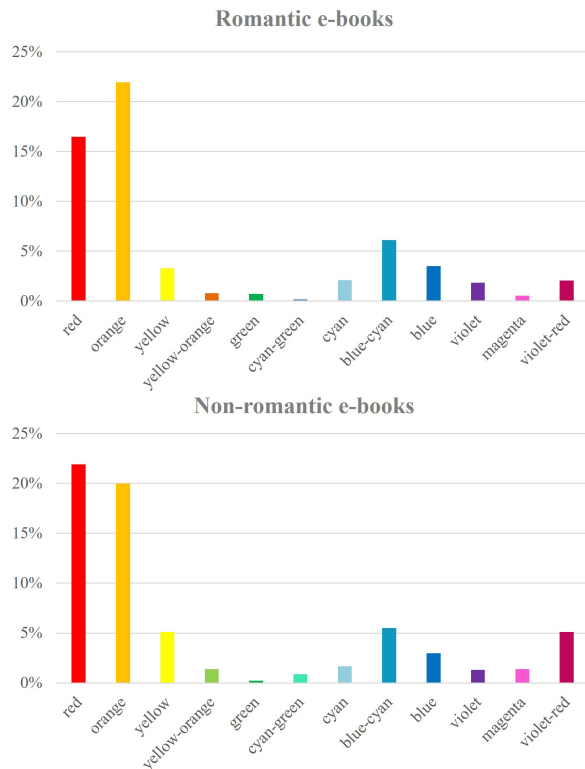


Fig. 6. Color distribution for romantic novel and non-romantic novel cover images.

Then, we add the interaction item between the cover images' color and the book title type to explore the moderating effect of book type. The possibility of a user's click behavior after seeing the cover is:

$$\begin{aligned} \text{CTR}_k = & \alpha + \beta \text{Romance}_k + \gamma \text{Cool}_k + \delta \text{Warm}_k + \\ & \varepsilon \text{Othercolorattributes}_k + \theta \text{Symmetryattributes}_k + \\ & \sigma \text{Anyperson}_k + \vartheta \text{Covertitlecor}_k + \mu \text{Bookinforattributes}_k + \\ & \pi \text{Romance}_k \times \text{Cool}_k + \rho \text{Romance}_k \times \text{Warm}_k + \varepsilon_k. \end{aligned} \quad (2)$$

The parameters π and ρ capture the effect of cool-colored e-book cover images and warm-colored e-book cover images on CTR, respectively, when the book belongs to the romance category.

4.2 Hypothesis testing

We estimate the linear regression model shown in Eqs. (1) and (2), and the result depends on the book cover image color information, symmetry information, and the properties of the book itself. Data were analyzed with IBM SPSS Statistics 21. Regarding the different e-book types, the results showed significant differences. The results are shown in Table 3.

Column (I) of Table 3 shows the estimated results of Eq. (1). The coefficients of the cool-colored and warm-colored cover images are 0.310 and 0.307, respectively, which are both significantly positive. The results show that the significant effect of warm and cool colors also exists in the case of complex colors. H1 is supported by the empirical results. To further explore whether the cool and warm colors of the e-book cover have different effects on different types of

Table 3. Tests of the moderation effect of book type.

	(I)	(II)
	Exposure CTR	Exposure CTR
Cool-colored	0.515***	0.733***
Warm-colored	0.554***	0.787***
Romance	0.210***	0.221***
Hue count	0.035	0.030
HVC counting	-0.124***	-0.127***
Average hue value	-0.022	-0.017
Average saturation value	-0.105	-0.108**
Average lightness value	-0.058	-0.095
Color contrast	-0.140	-0.144***
Anyperson	-0.167***	-0.166***
Covertitlecor	-0.146***	-0.167***
Book likes	-0.136	-0.144
Author fans	0.119	0.123
For men or women	-0.072	-0.056
X_MassCenter	0.059	0.065
Y_MassCenter	0.087**	0.080**
Romance novels × Cool-colored		0.214
Romance novels × Warm-colored		0.348***

** $p < 0.01$, *** $p < 0.001$.

e-books, we add the interaction term between hue and the book type in Eq. (2). As shown in column (II), the coefficient of interaction between romance novels and warm colors is 0.348 ($p < 0.05$), indicating that for romance novels, the effect of warm colors on click behavior can be significantly and positively enhanced. However, the interaction between romance novels and cool colors is not significant. H2 is also supported by empirical results.

4.3 Robustness check

Empirical research in color psychology operationalizes hue segmentation through a binary framework of cool versus warm spectra, yet methodological heterogeneity remains evident in defining categorical boundaries. To ensure the robustness of the experimental results, the Munsell hue circle was selected as the criterion for distinguishing cool and warm colors. Regression analysis was performed on the data again, and the results are shown in Table 4. Consistent with the results in the previous study, when the book type is romance, the effect of warm colors on click behavior is significantly enhanced, which proves the stability of the previous research results.

5 Conclusions

This study examines the effect of e-book cover images' color and their congruence with book-type text on book click-through rates. These results show that the warm and cool colors (vs. neutral colors) of the e-book cover images have a significant effect on the click-through rate of the book (H1), and the type text of the book can moderate the effect above. Specifically, the effect of warm (vs. neutral) colors is

Table 4. Tests of the moderation effect of book type.

	(I)	(II)
	Exposure CTR	Exposure CTR
Cool color	0.522***	0.748***
Warm color	0.552***	0.794***
Romance novels	0.221***	0.233***
Hue count	0.030	0.022
HVC counting	−0.124***	−0.128***
Average hue value	0.012	−0.011
Average saturation value	−0.104	−0.108**
Average lightness value	−0.066	−0.107
Color contrast	−0.137**	−0.141***
Anyperson	−0.161***	−0.160***
Covertitlecor	−0.155***	−0.177***
Book likes	−0.142	−0.139
Author fans	0.136	0.129
For men or women	−0.070	0.052
X_MassCenter	0.055	0.061
Y_MassCenter	0.079**	0.073**
Romance novels × Cool color		0.215
Romance novels × Warm color		0.360***

** $p < 0.01$, *** $p < 0.001$.

enhanced by the romance theme due to the romance-warm color association (H2). Romance novels with high exposure click rates mostly use warm colors such as red and orange. For romance novels, warm-colored book covers have a significant positive effect on promoting click-through rates, while cool-colored book covers have no significant effect.

5.1 Theoretical contribution

Our findings make several theoretical contributions to the existing literature. First, the study marks digital content cover images as cool-colored or warm-colored using an innovative methodology, depicts the attributes of hues of digital content products, and reveals their impacts. Warm and cool colors are well-documented concepts in visual and design fields^[5, 12, 28, 29] and can convey different meanings^[6]. Our study is the first to encode polychromatic image color warm and cool attributes using computer graphics algorithms and provide empirical evidence from polychromatic images. These images that contain more than a single hue stimulus and other complex visual elements have not been well investigated in previous studies^[30]. Therefore, our image processing approach can be extended to empirical studies of visual marketing, and the hue coding approach to polychromatic images will help to fill the research gap in image design studies.

Second, this research highlights how color impacts the clicking-through of digital content products in e-commerce. When consumers are attracted to the cover images, they click through and start trial reading before making a purchase decision. The trial uses before purchase are not as prevalent and convenient in physical products as in digital content. Previous research regards clicking as the measurement of purchase

intention, while we further discriminate clicking-through as the indicator of trial reading and capture the step before purchasing decisions. The focus on trial uses sheds light on the particular stage in digital content consumption at a greater granularity.

Third, our research reveals a meta-cognition of warm color and romance association among polychromatic images, which extends the semantic meaning research based on single hue presentation. By classifying the e-book types, we extended the love semantics of red in previous studies to include warm colors. The congruency between warm color and theme in line with text and image congruence on consumer behavior^[31–33] was identified to significantly affect consumers' purchase intention^[34], which enriches the literature on visual stimuli and product attribute congruency.

5.2 Managerial implication

Our findings provide insight to practitioners of digital content companies. First, color is important in conveying signals and emotions and should be taken into consideration when choosing designs. Practitioners can leverage trial reading by adopting cover images congruent with the digital content of matched themes. Future automatic cover design can code the rules of algorithms to optimize the design. Second, it would be beneficial for managers to use more warm colors for romance books. Using color design to gain competitive advantages has been adopted by travel, advertising, and construction companies. The managers of digital content platforms can also customize color scheme-fitting content, effectively convey information and attract target consumers. They should analyze the impact of cover image color to strive for higher user retention and conversion rates for the platform.

5.3 Limitations and future research

There are some limitations of this study. First, the study selected data from a single digital reading platform. Although the platform has many books and a large user population, whether the conclusion holds in different user groups among other countries remains unexamined. Second, this research categorizes fiction as romance and non-romance to verify the effectiveness of cold and warm colors. The non-romance book, although not featuring romance the most salient, may contain romance elements. Fiction can contain multiple themes among gongfu, history, sports, games, and mystery, making the classification complex. Future research may use more classification rules to find realistic and universal conclusions. Third, this research considers the mode of pushing a single book to users at a time. Future research can explore how the position of a single book on the interface influences when multiple books are pushed at the same time. Finally, due to the limitations of the sample data and processing techniques, we exclude images with a similar ratio of cool and warm colors. Future studies can develop different measurements to test the role of colors in polychromatic images.

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Conflict of interest

The authors declare that they have no conflict of interest.

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