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*Full Length Research Paper*

# The impact of social crowding on color saturation preference: The mediating role of threat to freedom and avoidance behavior

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**This study explores the impact of social crowding on color saturation preference and its internal psychological mechanism. In three studies (333 subjects), two different stimuli are used to manipulate the level of social crowding to probe into individuals' preference for product color saturation in socially crowded settings. The findings reveal that in socially crowded environments, individuals prefer products with low color saturation, where threat to freedom and the need to avoid have mediating effects. That is, in socially crowded settings, individuals' perceived threats to freedom are enhanced, which makes them more inclined to choose products with low color saturation to express their need to avoid and deal with the threats. This paper combines social crowding with product color saturation preference, enriches the research on social crowding and color marketing, and improves the theoretical system of social crowding theory. This study also provides insights of product package color strategies, and can help brands formulate more accurate color marketing strategies according to the environment of product sales channels.**

**Key words:** Social crowding, color saturation, threat to freedom, avoidance behavior, consumers' preference.

## INTRODUCTION

Social crowding has become increasingly common with the growing population and continuous urbanization. Crowding is ubiquitous in our life, as is seen in crowded subway cars and shopping malls, or around the popular scenic spots. The impact of crowded marketing environments on consumers has drawn more scholars' attention in recent years. Crowding refers to a state of psychological stress that result when one's demand for space exceeds the supply (Eroglu and Machleit, 1990;

Stokols, 1972). Since the last century, scholars have discussed the definition of social crowding, adding the social dimension to the physical aspects. Jing et al. (2018) defined social crowding as a subjective experience of an individual's intuitive perception of the physical distance between people in a fixed space. This paper adopts this definition.

It has been found that in socially crowded settings, as a result of the personal space violation, an individual feels

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that the component of others' existence increases and the individual's characteristics of self-identity weaken in the group. In order to satisfy the need of identity, the self-expression needs are activated, and the individual demands compensation by actively displaying personality through some behaviors, such as a bias towards products with some uniqueness (Morrison and Johnson, 2011; Xu et al., 2012). Matherly et al. (2018) proposed the brands' "Population Penalty" effect from the macro perspective of regions, pointing out that consumers living in crowded areas have significantly enhanced motivation to express their uniqueness and pursue new concepts in purchasing personalized clothing. However, there are also scholars with different views that social crowding leads to consumers' avoidance behavior, such as choosing products with safety implications (Maeng et al., 2013), which results in social avoidance, unwillingness to communicate with people, and tendency to complete data query through machines rather than face-to-face communication (Hou et al., 2021).

Does social crowding lead to a series of compensatory behaviors (such as pursuit of personality), or passive withdrawal and avoidance? At present, there is no unified mechanism for a comprehensive interpretation in the academic circle.

There are similar disputes in the field of color marketing. A study of Hagtvedt (2020) reveals that when users want to choose a friendly color, they prefer light colors to darker ones. Highly saturated colors are relatively strong and vivid. In the process of human evolution, strong colors have been associated with danger signals. Low saturation colors provide inner peace and tranquility as they seldom transmit signals of dangers and emotion (Walters et al., 1982). The low saturation Morandi colors win the favor of numerous consumers with its low profile and softness. However, from the perspective of metaphor, some scholars propose that highly bright colors can bring more comfort to consumers, while low brightness gives people a sense of discomfort (Jraissati et al., 2016). Given different views of scholars, are less saturated soft colors or highly saturated vivid colors more popular with consumers? And in a crowded environment, do individuals prefer high saturation products to demonstrate their personality out of their needs for uniqueness, or prefer low saturation color products out of avoidance needs to protect themselves from threats? At present, there is no clear explanation in extant literature. Therefore, this paper mainly tries to answer the following questions: (1) Does social crowding affect choice of color saturation, and (2) what is the underlying mechanism and influence process? The above questions have certain theoretical value in terms of enriching theories on the impact of social crowding on consumer behavior and color marketing. In practice, they can also provide a reference for enterprises in choosing appropriate product color strategies according to scenarios and channels.

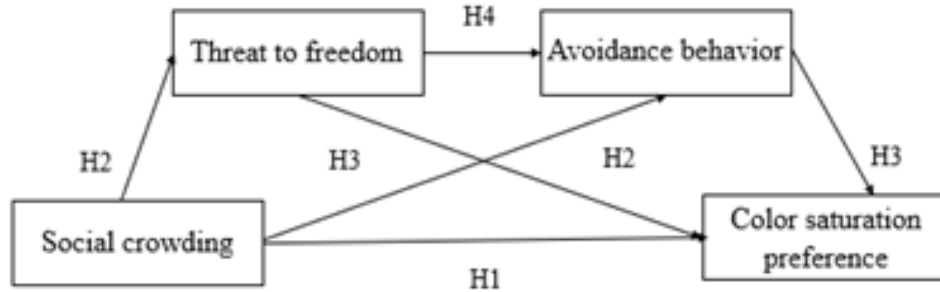
## LITERATURE REVIEW, THEORY AND HYPOTHESES

### Social crowding and color saturation preference

In a context of social crowding, individuals own less space than what they need, which leads to a sense of insecurity that their personal boundaries are offended (Worchel and Teddlie, 1976), and their perception of threats increases significantly. Previous studies have revealed that the sense of threat caused by crowding leads to changes in individual consumer behavior. Field studies of Levav and Zhu (2009) reveal that when individuals perceive threats due to space constraints, they compensate for the discomfort of limited freedom by choosing various types of products. The study of Ding and Zhong (2020) shows that perceived threats caused by social crowding promotes individual's intention of self-improvement, leading consumers to prefer self-improvement products; with COVID-19 epidemic as the research background, Kim and Kang (2021) find that social crowding increases people's perceived risk and attention to safe social distancing, thus reducing the evaluation of hedonic consumption. Do consumers alleviate their inner discomfort through their choice of color saturation? What is the underlying psychological motivation?

As the first visual element, color plays an important role in sensory marketing. The theory of color marketing that emerged as early as the last century has drawn the attention of marketing scholars again in recent years. The definition of color consists of three dimensions: hue, brightness and saturation. Hue is the most basic dimension of color, which has the most direct impact on individual cognition and emotion (Elliot and Maier, 2012; Labrecque and Milne, 2012); brightness measures the depth of colors, which affects consumers' judgment of products (Lee et al., 2014; Hagtvedt, 2020); saturation is the measure of the vividness or purity of colors (Huang et al., 2018), which affects consumers' choice and judgment preference and also plays an important role in the choice of consumer behavior. For example, previous studies reveal that high saturation colors can amplify spatial perception. When consumers need more space, they are more inclined to choose high saturation products (Hagtvedt and Brasel, 2017). Saturation can affect one's judgment of freshness, and food with color of low saturation is more likely to be considered stale (Kunz et al., 2020).

Generally speaking, previous studies have paid more attention to hue, focusing on the impact of different colors on consumer behavior through physiological, psychological and cultural factors, and less research has been carried out on color saturation. In recent years, scholars no longer limit the research to different colors themselves, but also direct the research to the impact of specific dimensions of color on consumers' psychology and behavior. Social crowding leads to individual



**Figure 1.** Proposed research framework.  
Source: Authors

psychological changes, and the color saturation of different products has an impact on individual psychology and cognition. Therefore, this paper puts forward the following hypotheses:

**Hypothesis 1a:** Social crowding leads consumers to prefer products with low color saturation.

**Hypothesis 1b:** Social crowding leads consumers to prefer products with high color saturation.

### The mediating effects of perceived threats and avoidance behavior

In a context of social crowding, individuals have a sense of insecurity (Worchel and Teddlie, 1976), and their perception of threats increases significantly. There are several previous studies on consumers' avoidance behavior in response to threats (Figure 1). Hui (1991) found that crowding leads to the lack of individuals' sense of control resulting in avoidance behavior.

In a crowded environment, consumers tend to be conservative and prefer products with safety implications as a result of their social avoidance (Maeng et al., 2013). In terms of price preference, people are willing to pay lower prices for products in crowded shopping malls out of avoidance behavior (O'Guinn et al., 2015). Regarding consumers' interaction, there will be avoidance behavior in crowded settings, where people are unwilling to communicate with others and the willingness to interact with personified brands declines (Hwang et al., 2012; Hou et al., 2021; Puzakova and Hwang, 2017).

Avoidance behavior is a way of coping with crisis when an individual is threatened. In the field of consumer behavior, previous studies demonstrate a variety of ways to deal with crisis by changing consumer behavior, which can be divided into direct response, compensatory consumption and (mostly) avoidant consumption (Sun et al. 2021). Avoidant consumption strategies can be divided into psychological avoidance, behavioral avoidance and cognitive avoidance.

Examples include nostalgic consumption to alleviate inner anxiety (Wang et al., 2011); long immersion in

audio-visual consumption (watching videos or enjoying music) for self-avoidance by distraction (Batra and Ghoshal, 2017; Kim and Rucker, 2012; Moskalenko and Heine, 2003); choosing products with transparent packaging to avoid uncertainty (Chen and Zheng, 2015), preference to touching soft products, etc. (Ding and Gong, 2016). Accordingly, this paper puts forward the following hypotheses:

**Hypothesis 2:** Social crowding affects the choice of product saturation through the mediating effects of threat to freedom

**Hypothesis 3:** Social crowding affects the choice of product saturation through the mediating effects of avoidance behavior

To sum up, based on the theories of social crowding and color marketing, we intend to reveal the impact of social crowding on product color saturation preference, namely, when individuals feel threatened, they will have certain tendency to choose product color saturation as an avoidance strategy. Accordingly, this paper puts forward the following hypothesis:

**Hypothesis 4:** Social crowding affects the choice of product saturation through the serial mediating effects of threat to freedom and avoidance behavior.

### METHODOLOGY

Across three studies, important underlying assumption of the current research was confirmed. Specifically, study 1 tests the main proposition that social crowded environment cues should increase relative preference for low saturated color products. Afterwards, in study 2, the mediating mechanism underlying the superficial phenomenon was explored, to show the mediating role of threat to freedom and avoidance behavior. Then, in study 3, findings provide evidence that it is not anxiety that plays the mediating role, which rules out the effect of anxiety as an alternative explanation.

#### Study 1: The impact on consumers' choice of product color saturation in socially crowded settings

Provides an initial test of Hypothesis 1 aimed to explore the causal relationship between social crowding and product color saturation





A. Social crowding group

B. Non-crowding group



A. Low saturation bag

B. High saturation bag

**Figure 2.** Stimuli and materials for study 1.

Source: Authors

preference.

## Method

### Sample

In Study 1, a single factor (social crowding vs. non-social crowding) between-groups design was adopted. 120 questionnaires were collected; the sample was collected in both offline and online formats, both in the form of an electronic questionnaire. The online distribution used a snowball method to ask friends and family to share the questionnaire link, while for offline method we used street interviews to find respondents and ask them to scan the QR code to fill in the electronic questionnaire. Two respondents with visual impairment and 18 questionnaires with a response time of less than 120 seconds were eliminated. A total of 100 valid questionnaires were received. The average age of the subjects was 32.16 years old. At  $\alpha = 0.05$  and power = 0.80, the sample size has a high effect size (which is  $0.6 > 0.5$ ).

### Procedure

According to previous studies, images and text were used to make the subjects enter the scene by means of imagination. About grouping, all the data were collected from the questionnaires imported into a data centre, where the designer of the questionnaire can see the number of questionnaires distributed and set quotas simultaneously. The questionnaires are divided into crowded and non-crowded versions depending on the degree of crowding

manipulated.

The link of the crowded or non-crowded version of the questionnaire was randomly distributed to the respondents and the quota for each group was controlled according to the number of completed questionnaires in real time. This made the number of questionnaires distributed to both groups to be consistent and meet the basic quantity requirements.

Finally, data were grouped from subjects who completed the crowded version of the questionnaire into the crowded group and data from subjects who completed the non-crowded version of the questionnaire into the non-crowded group.

The subjects were divided into social crowding group ( $n = 58$ ) and non-crowding group ( $n = 42$ ) with a single factor inter-group design. With the experimental images of Maeng et al. (2013) as stimuli (Figure 2), the subjects were asked to describe the scenes of the images, recall the experience of similar scenes and make a written description (Ding and Zhong, 2020). After responding to the questions, the subjects were asked to evaluate the level of crowding of the image on a 9-point scale (1 = very loose, 9 = very crowded) as the test item of social crowding.

Following the manipulation of the social scene, the subjects were told to imagine that they needed to buy a bag, and then 2 yellow bags were presented to them. The experimental materials of the 2 bags were made with Photoshop software, and the brightness and hue were controlled. As shown in Figure 2, the size and shape of the 2 bags were completely the same while the color saturations were different. The HSL parameter of the high saturation yellow bag was 51, 78, 89, and the HSL parameter of the low saturation bag was 51, 24, 89. The subjects were reminded to imagine that they were in the scene of the image. Referring to the measurement of product selection preference in previous studies Zheng et al. (2018)

**Table 1.** Correlation analysis of variables in Study 1.

| Variable                    | Mean value | SD    | Gender | Age    | Social crowding | Color saturation preference |
|-----------------------------|------------|-------|--------|--------|-----------------|-----------------------------|
| Gender                      | 1.85       | 0.359 | 1      |        |                 |                             |
| Age                         | 32.16      | 13.06 | -0.141 | 1      |                 |                             |
| Social crowding             | 5.39       | 3.484 | 0.074  | -0.135 | 1               |                             |
| Color saturation preference | 4.86       | 2.93  | 0.162  | 0.09   | 0.193*          | 1                           |

Source: Authors

and Gong et al. (2021) asked the subjects to state their preference for the two bags at this time (1 = completely like the bag on the left side and 9 = completely like the bag on the right side); while the bags with low saturation and high saturation were placed on the left and right sides, respectively.

Finally, the subjects were asked to fill in the content of their demographic characteristics (including gender and age). They were also asked whether they had color recognition obstacles, so as to eliminate the subjects who did not meet the requirements.

## RESULTS

### Manipulation checks

The 100 qualified samples collected were analyzed, and independent sample t-test was conducted to test whether the crowding was manipulated successfully. The results show that the degree of crowding ( $M = 8.26$ ,  $SD = 0.947$ ) felt by the subjects immersed in the crowded scene created by the image was significantly higher than those immersed in the non-crowded scene ( $M = 1.43$ ,  $SD = 0.59$ ),  $p = 0.000 < 0.05$ ,  $F(1, 98) = 9.546$ , Cohen's  $d = 8.66$ ). Therefore, our manipulation of social crowding with the images was successful.

### Correlation analysis

Firstly, correlation analysis of the main variables was carried out. It can be seen from Table 1 that there is a statistically significant correlation between the independent variable, social crowding and color saturation preference ( $\beta = 0.193$ ,  $p < 0.05$ ) and there is no statistical significant correlation between gender and age and social crowding and saturation preference. This lays a foundation for testing hypothesis H1.

### Preference

To verify the main effect, analysis of color saturation preference was carried out. An independent sample t-test was conducted with the subjects' preference for bags; different color saturation was the dependent variable and social crowding was the independent variable. The results showed that the subjects' preference for bags with different color saturation was significantly different between the crowding group and the non-crowding

group. The preferred color saturation of the social crowding group ( $M = 4.41$ ,  $SD = 2.932$ ) was significantly lower than that of the non-crowding group ( $M = 5.48$ ,  $SD = 2.848$ ),  $F(1, 98) = 0.032$ ,  $p = 0.072 < 0.1$ , Cohen's  $d = 0.4$ , which is marginally significant. That is, in crowded settings, subjects prefer to choose goods with low saturation, and they prefer to choose goods with high saturation in open settings. Therefore H1a is true and H1B is not true.

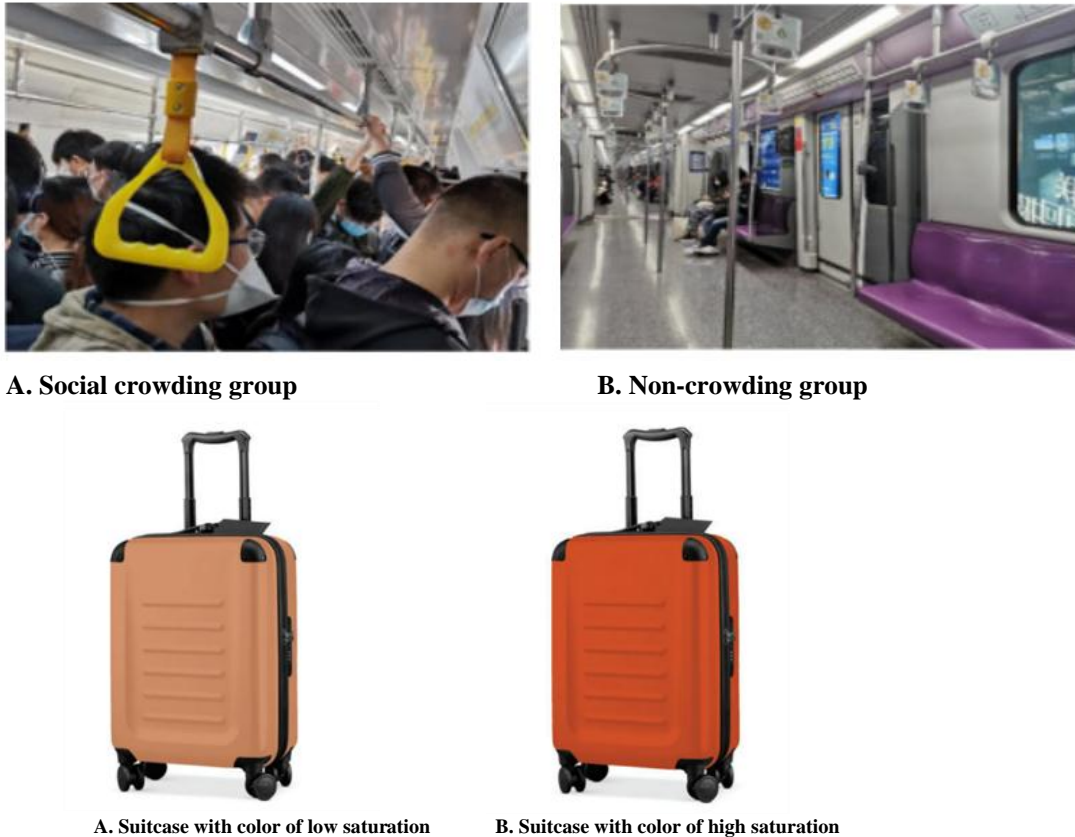
### Study 2: The mediating effects of threat to freedom and avoidance behavior

In Study1, it was found that in the context of social crowding, individuals prefer to choose products with low saturation, and the hypothesis H1a was verified. Building upon Study 1, Study 2 further confirmed the robustness of the conclusion and optimized as well as deepened it in three aspects. First, the subjects were asked about their perception of the number of people in the environment and the social dimension was introduced to more accurately measure the level of social crowding. Second, instead of the foreign streets and characters as manipulation of social crowding in Experiment 1, the scenes of Chinese subway cars were used as the materials in Study 2 to enhance the subjects' sense of reality and identification. Third, exploration of the mediating mechanism was added to probe into the internal mechanism underlying the superficial phenomenon.

### Method

#### Sample

A recruitment notice for the experiment was posted on campus, inviting university students to participate in the behavioral experiment. 150 subject were recruited from University in China. Two sets of questionnaires were applied in this experiment, which differed in the manipulated picture environment provided to the subjects. The different questionnaires were distributed in the order in which the subjects were recruited. The subjects who filled in the pictures of crowded underground carriages were classified as the crowded group and



**Figure 3.** Stimuli materials for study 2.  
Source: Hagtvedt and Brasel, 2017

the subjects who filled in the pictures of empty underground carriages were classified as the non-crowded group. The authors created reverse items in the items measuring avoidance behavior to test the seriousness of the subjects. 22 questionnaires with inconsistent responses were deleted, and finally 128 valid questionnaires were received. The average age of the subjects was 29.79 years old. The subjects were randomly divided into social crowding group ( $n = 74$ ) vs. Non-crowding group ( $n = 54$ ). At  $\alpha = 0.05$  and power = 0.80, the sample size had an effect size of 0.5, the level of a medium effect.

### **Procedure**

Images and filling in the blanks with words were used to induce the imagination of the subjects and guide them into the scene. Referring to the study of Cai et al. (2021), a group of images of Chinese subway cars (cars full of passengers vs. cars with few passengers) were selected as the stimuli to manipulate the social crowding (Figure 3). The subjects were asked to evaluate the level of crowding in the image (1 = very loose, 9 = very crowded) and the perception of the number of people in the scene

(1 = few people, 9 = many people) on a 9-point scale as the manipulation check items of social crowding. The average value of level of crowding and perceived number of people was taken as the variable of social crowding.

In study 2, another group of suitcases with different color saturation was selected as the materials. The two images of suitcases were from the research materials of Hagtvedt and Brasel (2017). As shown in Figure 3, the hue, brightness and size of the images were completely the same while the color saturations were different. The HSL parameter of the suitcase with high saturation was 22100, 80, and that of the suitcase with low saturation was 22, 50, 80. The subjects were told to imagine that they needed to buy a suitcase, and then were presented with two orange red suitcases. The subjects were reminded to imagine that they were in the scene of the image and to state their preference for the two suitcases at this time (1 = totally like suitcase on the left side, 9 = totally like the suitcase on the right side). The suitcases with low saturation and high saturation were placed on the left and right sides randomly for balance. Finally, the collected data were sorted into a variable of color saturation preference. The higher the value of the variable the higher was the preference for the color with high saturation.

The measurement of threat to freedom in the study of Shen and Dillard (2005) was translated into Chinese to form 4 items to measure the threat to freedom felt by the subjects under the stimuli of crowding and non-crowding images. The subjects were required to evaluate whether the statements in the scale were consistent with their current actual feelings. A 9-point Likert scale was used, where 1 means the statement is very inconsistent with the actual feelings and 9 very consistent. The specific items are: "My freedom of choice is threatened", "I feel forced to make a decision", "I feel manipulated" and "I feel under pressure". At the same time, the subjects were reminded again that they were to respond in the scene of the image. In this experiment, the Cronbach's alpha of the scale was 0.938, which means good internal consistency.

The avoidance behavior of subjects in crowded and non-crowded environments was measured, and the images of corresponding crowded or non-crowded subway cars were presented again (Figure 3) according to the different groups of the subjects. The avoidance scale is adapted from Hwang et al. (2012), which mainly measures 2 dimensions: the impact of avoidance on behavior, and subordination relationship with others. It consists of 4 items, and the subjects are required to tell whether the statement in the scale is consistent with their current actual feelings. A 9-point Likert scale was used, where 0 means the statement is very inconsistent with the actual feelings and 9 very consistent. In the measurement of the impact of avoidance on behavior, the items adopted were: "I like this space" (reverse) and "I want to leave and do not want to return to this space". In the measurement of subordination relationship, the items used were "I welcome strangers around me and am willing to chat with them" (reverse) and "I don't want to contact others and don't want to talk to them". In this experiment, the Cronbach's alpha of the scale was 0.874, which means good internal consistency.

Finally, other variables were measured in the experiment and the subjects were asked about their feelings at the moment. The specific items were "I feel very positive", "I feel the environment is noisy" and "I feel very anxious". A 9-point Likert scale was used again, where 0 means the statement is very inconsistent with the actual feelings and 9 very consistent. Finally, the subjects were asked to fill in the content of demographic characteristics (including gender and age). They were asked whether they had color recognition obstacles, so as to eliminate the subjects who did not meet the requirements.

## Results

### Manipulation checks

The 128 samples collected were analyzed, and the

independent sample t-test was conducted to test whether the crowding was manipulated successfully. The results showed that the level of crowding ( $M = 8.00$ ,  $SD = 1.00$ ) felt by the subjects immersed in the crowded scene created by the image was significantly higher than those immersed in the non-crowded scene ( $M = 1.75$ ,  $SD = 0.87$ ),  $F(1, 126) = 9.546$ ,  $p = 0.000 < 0.05$ , Cohen's  $d = 6.67$ . Therefore, our manipulation of social crowding with the images was successful.

### Correlation analysis

First, correlation analysis of the variables was carried out to preliminarily test the hypotheses. The relationship between social crowding and saturation preference was significant ( $\beta = 0.296$ ,  $p < 0.01$ ), which was significantly correlated with the mediating variables threat to freedom ( $p < 0.01$ ) and avoidance behavior ( $p < 0.01$ ). The correlation coefficient between social crowding and threat to freedom was 0.602, and the correlation coefficient between social crowding and avoidance behavior was 0.644. There is a statistically significant correlation between the mediating variable threat to freedom and the dependent variable product color saturation preference ( $\beta = 0.415$ ,  $p < 0.01$ ), and there is a statistical significant correlation between the mediating variable avoidance behavior and the dependent variable color saturation preference of ( $\beta = 0.424$ ,  $p < 0.01$ ). So, hypotheses H1 and H2 were preliminarily verified, laying a foundation for the following analysis (Table 2).

### Preference

An independent sample t-test was carried out on the subjects' preference for bags with different color saturation as the dependent variable and social crowding as the independent variable. The average value of perception of crowding and perceived number of people was taken as the variable of the social crowding. The results showed that the subjects' preference for suitcases with different saturation was significantly different between the crowding group and the non-crowding group. The preference for suitcases with high saturation of the social crowding group ( $M = 4.58$ ,  $SD = 3.105$ ) was significantly lower than that of the non-crowding group ( $M = 6.31$ ,  $SD = 2.281$ ),  $F(1, 126, 98) = 11.338$ ,  $p = 0.000 < 0.001$ , Cohen's  $d = 0.64$ . That is, in crowded settings, the subjects prefer to choose goods with low saturation, and they prefer to choose goods with high saturation in open settings.

Finally, to better eliminate the interference of the image stimulation on the subjects, we also took anxiety and emotional positiveness as control variables in addition to gender and age to test the main effects in Study 2 again.

An independent sample t-test was conducted with

**Table 2.** Correlation analysis of variables in Study 2.

| Variable                    | Mean value | SD    | Gender | Age    | Social crowding | Threat to freedom | Avoidance behavior | Color saturation preference |
|-----------------------------|------------|-------|--------|--------|-----------------|-------------------|--------------------|-----------------------------|
| Gender                      | 1.63       | 0.484 | 1      |        |                 |                   |                    |                             |
| Age                         | 29.79      | 9.481 | 0.95   | 1      |                 |                   |                    |                             |
| Social crowding             | 0.58       | 0.496 | -0.903 | 0.178* | 1               |                   |                    |                             |
| Threat to freedom           | 4.3        | 2.66  | -0.115 | 0.038  | 0.602**         | 1                 |                    |                             |
| Avoidance behavior          | 5.908      | 2.23  | 0.467  | 0.054  | 0.644**         | 0.636**           | 1                  |                             |
| Color saturation preference | 5.31       | 2.907 | 0.105  | -0.055 | 0.296**         | 0.415**           | 0.424**            | 1                           |

Source Authors

anxiety being the independent variable and social crowding (1 = social crowding group; 0 = non-social crowding group) as the dependent variable to explore whether the above variables are related to social crowding. The results showed that the anxiety of the subjects increased in the social crowding group ( $M = 5.3$ ,  $SD = 2.584$ ), which was significantly higher than that of the non-crowding group ( $M = 3.2$ ,  $SD = 2.429$ ),  $p = 0.000 < 0.05$ ,  $F(1126) = 0.014$ , Cohen's  $d = 0.84$ . In terms of positiveness, the subjects' positive emotion under the stimulation of crowded images ( $M = 3.38$ ,  $SD = 2.018$ ) was significantly lower than that under non-crowded images ( $M = 5.5$ ,  $SD = 1.891$ ),  $p = 0.000 < 0.05$ ,  $F(1126) = 2.243$ , Cohen's  $d = 1.1$ .

Logistic regression was conducted to test Hypothesis 1, with the saturation preference (1 = preference for low saturation, 0 = preference for high saturation) as the dependent variable, and the level of social crowding (the average of the subjects' perceived level of crowding and number of people) as the independent variable (1 = not uncrowded at all, 9 = very crowded). The results showed that social crowding has a statistically significant negative impact on saturation preference ( $Beta = -0.334$ ,  $p = 0.000$ ). In addition, with age, gender, anxiety and emotional positiveness as control variables, the above results were still statistically significant ( $Beta = -0.221$ ,  $p = 0.039$ ). It can be seen that while social crowding causes subjects' anxiety to a certain extent, it does not significantly affect subjects' preference for product color saturation.

### Mediation analyses

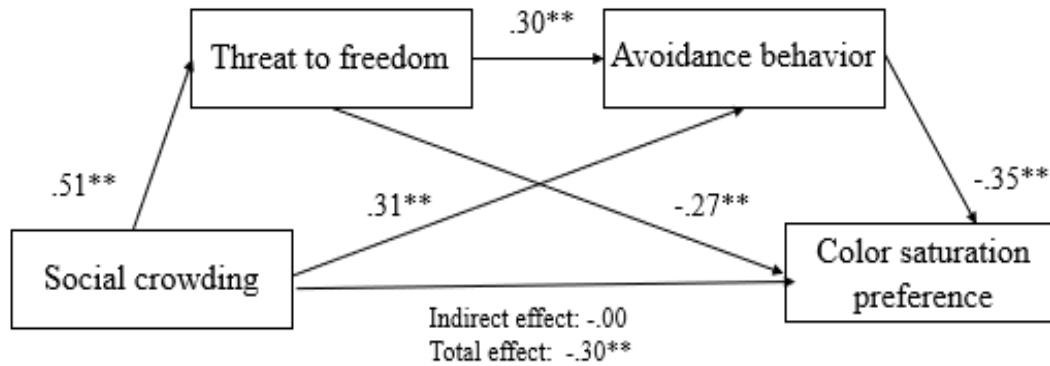
First, mediating effect analysis along the pathway of "social crowding → threat to freedom → low saturation color" was carried out to verify whether social crowding affects the choice of product color saturation via the mediating effects of threat to freedom. Referring to the method of Hayes (2013), Model 4 in PROCESS was used for the verification. With social crowding as the independent variable, saturation preference as the dependent variable and threat to freedom as the

mediating variable, the indirect effect was statistically significant (95% CI = [-0.3332, -0.0584]). This shows that there was a mediating effect, while the direct effect became statistically insignificant (95% CI = [-0.2938, 0.0756]). It showed that the impact of social crowding on saturation preference is transmitted through threat to freedom, and Hypothesis 2 is true.

Mediating effect analysis along the pathway of "social crowding → avoidance behavior → low saturation color" was carried out to verify whether social crowding affects the choice of product color saturation through the mediating effect of avoidance behavior. With social crowding as the independent variable, saturation preference as the dependent variable and avoidance behavior as the mediating variable, the results showed that the indirect effect was statistically significant (95% CI = [-0.3959, -0.0682]), indicating that there was a mediating effect, while the direct effect became statistically insignificant (95% CI = [-0.2741, 0.1137]). It showed that the impact of social crowding on saturation preference is transmitted through avoidance behavior. The above results showed that social crowding affects the choice of saturation preference through threat to freedom and avoidance behavior, and Hypothesis 3 is true.

The serial mediating effects of threat to freedom and avoidance behavior was further analyzed. The PROCESS plug-in in SPSS was used and Model 6 was selected. Taking social crowding as the independent variable, color saturation preference as the dependent variable, and threat to freedom and avoidance behavior as the serial mediators. It can be seen from the previous analysis that age, gender, anxiety and emotional positiveness do not significantly affect social crowding and color saturation preference, so they were not included in the control variables. The path coefficient is shown in Figure 4. The R-square of the results of the regression was 0.33,  $F = 15.82$ ,  $p < 0.001$ .

Bootstrap sampling was conducted to test the mediators. The indirect effect along the pathway "social crowding → threat to freedom → color saturation" with threat to freedom as a mediator was -0.14 (95% CI = [-



**Figure 4.** The serial mediating effects of threat to freedom and avoidance behavior between social crowding and color saturation preference.  
Source: Authors

0.2875, - 0.0041], in which 0 was not included, and the indirect effect was significant. The indirect effect along the pathway “social crowding → avoidance → color saturation” with avoidance as a mediator was -0.0533, (95% CI = [- 0.1329, - 0.0027], in which 0 was not included, and the indirect effect was statistically significant. The indirect effect along the pathway “social crowding → threat to freedom → avoidance → color saturation” with threat to freedom and avoidance as mediators was 0.1089, (95% CI = [- 0.2498, - 0.0093], in which 0 was not included, and the indirect effect was statistically significant. The total indirect effect was -0.30 (95% CI = [- 0.4508, - 0.1283]), which was statistically significant, while the direct effect was 0.0002 (95% CI = [- 0.2041, 0.2037]). So Hypothesis 4 is true.

### Study 3: Ruling out the effect of anxiety as an alternative explanation

Study 3 verified the main effect of social crowding on saturation preference again. At the same time, it aimed to rule out the mediating effect of anxiety as an alternative explanation.

#### Method

##### Sample

115 subjects were recruited. The average age of the subjects participating in the experiment was 27.5 years old. The subjects were randomly assigned to the social crowding group or non-crowding group ( $n_{\text{crowding group}} = 55$  vs.  $n_{\text{non crowding group}} = 60$ ). In order to ensure that the subjects' responses were serious, we deleted the questionnaires answered within less than 160 seconds. A total of 105 valid questionnaires were received ( $n_{\text{crowding group}} = 47$  vs.  $n_{\text{non crowding group}} = 58$ ).

#### Procedure

As in Study 2, the images of Chinese subway cars (cars full of passengers vs. cars with few passengers) were used to manipulate the scenarios of social crowding, and the subjects were randomly assigned to the crowding and non-crowding groups. Using the combination of text and image manipulation, the subjects were asked to fill in the blanks to describe the content of the images and recall similar scenarios encountered before. After completing the text task, the subjects were asked to evaluate the level of crowding and perceived number of people in the images on a 9-point scale. As social crowding includes physical and social dimensions, we took the average of the level of crowding and perceived number of people as the social crowding variable (Figure 5).

In terms of measurement of saturation preference, the images of yellow bags used in Study 1 were used again as the materials in Study 3. The authors changed their question this time, and asked the subjects to make a forced either-or choice to eliminate the impact of questioning method and data analysis method on the results and enhance the robustness of the conclusion. The subjects were reminded to imagine that they were in the scenario of the image and they needed to buy a bag at the moment. They were required to choose one from the two bags (1 = bag on the left side and 2 = bag on the right side) (bags with different color saturation were presented on the left and right sides randomly for balance). The subjects' choices were sorted into a color saturation preference variable (1 = bag of low saturation, 2 = bag of high saturation) for regression analysis.

Other variables were measured in the experiment. The subjects were asked about their feelings at the moment. The specific items were “I feel very positive”, “I feel the environment is noisy” and “I feel very anxious”. Finally, the subjects were asked to fill in the content of demographic characteristics, including gender and age, and report whether they had color recognition obstacles,



**A. Social crowding group**



**B. Non crowding group**

**Figure 5.** Stimuli Materials in Study 2/3.  
Source: Authors

so as to eliminate the subjects who did not meet the requirements.

## Results

### Manipulation checks

The 105 qualified samples collected were analyzed, and the independent sample t-test was conducted to measure the success of the manipulation of social crowding. The results showed that the level of crowding ( $M = 8.26$ ,  $SD = 0.947$ ) felt by the subjects immersed in the scenario of the crowded subway car was significantly higher than those immersed in the non-crowded scenario ( $M = 1.43$ ,  $SD = 0.59$ ),  $F(1, 103) = 9.546$ ,  $p = 0.000 < 0.05$ . Cohen's  $d = 8.66$ ,  $r = 0.97$ . Therefore, the manipulation was successful.

### Preference

Upon doing the Pearson's chi-square test, 76.60% of the subjects in the non-crowding group chose the high saturation, and 23.40% chose the low saturation. 56.90% of the subjects in the crowding group chose the high saturation, and 43.10% chose the low saturation. It can be seen that in a socially crowded environment, the subjects' preference for high saturation products decreases significantly, and the number of people choosing low saturation products increases. It is found that the crowding or non-crowding group has significant impact on choice of saturation ( $\chi^2 = 4.472$ ,  $p = 0.034 < 0.05$ ), and the Cramer's  $V = 0.21$ . The social crowding variable is moderately correlated with choice of saturation. Therefore, Hypothesis 1a is verified again: social crowding promotes the preference for low saturation products.

### Alternative explanation

As to whether anxiety can be a mediator, independent sample t-test was used to explore the direct effect of social crowding and anxiety. The results showed that anxiety of the subjects in the social crowding group ( $M = 5.28$ ,  $SD = 2.517$ ) was significantly higher than that of those in the non-crowding group ( $M = 4.26$ ,  $SD = 2.832$ ),  $F(1, 103) = 1.909$ ,  $p = 0.057 < 0.01$ , Cohen's  $d = 0.38$ . So, does anxiety affect preference for product saturation? We took anxiety as a mediator in an alternative explanation and used Model 4 in PROCESS to test whether anxiety plays a mediating role.

The results showed that the indirect effect along the pathway "social crowding  $\Rightarrow$  anxiety  $\Rightarrow$  saturation preference included 0 (95% CI = [-0.1752, 0.2234]), so anxiety was not a mediator. This indicates that more subjects in the social crowding group did not choose the low saturation colors because of anxiety, so it ruled out anxiety as an alternative explanation of the underlying mediating mechanism.

## DISCUSSION

Three studies were conducted to demonstrate the impact of social crowding on the choice of product color saturation. Two stimuli were used to manipulate the social crowding, and two methods were used to measure the preference for product color saturation. Study 1 tested the causal relationship between social crowding and product color saturation preference. In Study 2, the images for manipulation and stimuli were replaced to re-test the impact of social crowding on the choice of product color saturation, and verify the mediating effects of threat to freedom and avoidance behavior.

Specifically, when consumers are in a crowded environment, the limited space leads to the limitation on

personal activities, resulting in the perception of threat to freedom. This induces the consumers' mentality of avoidance and escape. Under the mediating effects of threat to freedom and avoidance, consumers will choose products with low color saturation as the expression of avoidance behavior. Study 3 used different data analysis methods to rule out the effect of anxiety as a mediator.

### Theoretical contribution

First, this paper enriches the research of social crowding theory on consumer buying behavior. Previous research on social crowding in the field of marketing rarely explored the direction of sensory marketing, but mainly focused on the impact on word-of-mouth communication, consumption types and satisfaction (Consiglio et al., 2018; Coskun et al., 2019; Jin, 2020; Eroglu et al., 2005). Few studies (Feng et al., 2022), probe into the combination of social crowding and color. As product color is an important element of product visual design, research on product color is of great help to promotion of sales. Therefore, this paper combines social crowding with product color saturation preference (environment with visual senses), enriches the research on social crowding and color marketing, and improves the theoretical system of social crowding.

Secondly, this paper contributes to the theoretical research of color marketing from the perspective of color saturation. While color consists of hue, saturation and brightness, more attention was paid to hue and less to color saturation in previous studies (Marozzo et al., 2020; Lim et al., 2020; Anne et al., 2021). In terms of the combination of color saturation and sensory marketing, existing research focuses mainly on the taste. For example, it is found that color saturation affects people's perception of food health and taste, and the relationship between taste and temptation avoidance (Kunz et al., 2020; Pomirleanu et al., 2020). However, there is a certain gap in combination of saturation with visual marketing and scene marketing. This paper expands the theory of color saturation and sensory marketing to a certain extent.

### Practical implications

This study provides more detailed conditions for the use of product color strategies, and can help brands formulate more accurate color marketing strategies according to the environment of product sales channels. Product color saturation has an important impact on consumers' attention (Hagtvedt and Brasel, 2017). To seize the marketing opportunity in the highly competitive homogeneous market, it is of particular importance to capture the attention of consumers. In order to win consumers' attention to products at the terminals, some brands make bold innovation and adopt high saturation

colors to gain consumers' attention and favor. However, studies find that in a crowded social environment, consumers are more willing to choose products with low saturation out of the need to avoid.

Secondly, this study can help businesses formulate better publicity and accurate push strategies based on consumption scenarios. In terms of physical channels, businesses can choose colors with low saturation for product advertising in crowded subway space. They can sell products with lower saturation in the service area, and mainly choose products with lower saturation for promotion in crowded shopping malls. With the popularity of mobile Internet and mobile terminals, consumers' shopping is no longer limited to offline channels. The development of Internet enables consumers to use mobile phones for online shopping anytime and anywhere. From the perspective of online channels, businesses can use LBS technology to more accurately push goods or advertisements with different colors according to the regions and crowding level of the consumers, and use the avoidance mechanism caused by social crowding to display products and designs with corresponding color saturation, so as to enhance the effect of precision marketing.

### Research limitations and future research directions

This paper has the following limitations. First, the data collected through the questionnaires was used as the main sample source of the study. The subjects were confronted with images, and no real crowded scenarios and open scenarios were used for the experiments. In the future, field experiments can be conducted to further test the impact of social crowding on color saturation preference. Second, products of warm color system (yellow and orange) were selected as experimental materials for testing, and the interference of color temperature was not eliminated. Cold and warm colors may have different effects on people's senses. For example, the warm color system can provide people with warmth, while cold color system can create a sense of coldness (Elliot and Maier, 2014). Therefore color temperature may affect the perceived level of threat caused by social crowding. The effects of color temperature can be further discussed in the future research.

### CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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