

# Does the Average Color Influence Selection?

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**Abstract.** The Goldilocks effect is the tendency to select the middle choice when three choices that can be expressed in three levels, such as size and price, are presented. We investigate the possibility that the Goldilocks effect can also be applied to color and that it unintentionally distorts the choice. Specifically, we hypothesized that when presented with three choices consisting of two different colors and their average color (the average of the two colors), people would choose the average color, and we conducted a crowdsourcing experiment. The experiment results showed that people did not tend to choose the average color option. However, analysis by gender showed that females tended to select the average color option while males did not. In addition, when the average colors were similar to one of the two colors in the three options, both males and females tended to select the less similar different color option.

**Keywords:** Color, Selection Behavior, Goldilocks Effect

## 1 Introduction

People make many choices in everyday life, such as when purchasing products, making hotel reservations, voting in popularity contests and elections, eating food, and selecting what to wear. The choice of a single product's choice is influenced by various factors, for example, price, quantity, package design, color, display location, and the absence of pop-outs.

Many studies have been conducted in cognitive science and developmental psychology on selection behavior. One of the psychological effects of choice is the Goldilocks effect, in which people tend to choose the middle option when given three choices in a stepwise manner. For example, when French fries are sold in three different sizes (S, M, and L), the middle-sized serving is more likely to be chosen.

Priluck et al. [1] suggested that the color factor may influence product selection and that sellers should consider the color of the product and package in their marketing strategies. Kobayashi et al. [2] also showed that color variation influences purchase intention, enjoyment, anxiety, and satisfaction at the time of selection. As shown in the above studies, it is clear that a product's color has some influence on selection behavior. It is common for a certain product to have color variations, but if the choice is guided by the color of other products, not the product itself, the choice may be distorted. If this

applies to choice behavior other than product selection, such as elections and popularity contests, it would be a significant problem.

We expected that the Goldilocks effect might also apply to color. Specifically, we hypothesized that, given a choice of three colors, if one of the three was a color with values intermediate between those of the other two choices in terms of hue, saturation, lightness, or RGB value (hereafter referred to as an "averaged color"), people would be more likely to choose it. If the Goldilocks effect also appears with color, then it is likely that the selection would be distorted by the type of colors in the selection target group.

In this paper, we investigate the influence of the color factor on choice behavior by using crowdsourcing to examine the choice behavior on a large scale when two and three choices are presented. In addition, we compare the averaged color choice rate between the two- and three-choice scenarios and clarify whether the Goldilocks effect is also manifested in color.

## 2 Related Work

Regarding package design, Terry et al. [3] found that the product name's font strongly influences product evaluation. However, as well as font and design, color is also considered an essential factor in package design.

In an investigation of the influence of color on things, Priluck et al. [1] showed that a product's color is a significant factor in marketing strategies, and the color factor is thought to have some influence on choice behavior. Fergus [4] studied food color and consumer consumption behavior and found a correlation between beverage consumption and color. However, only a few studies on product colors, such as these, have focused on multiple product colors. We investigate the influence of color factors on choice behavior by conducting a survey focusing on the color of multiple products.

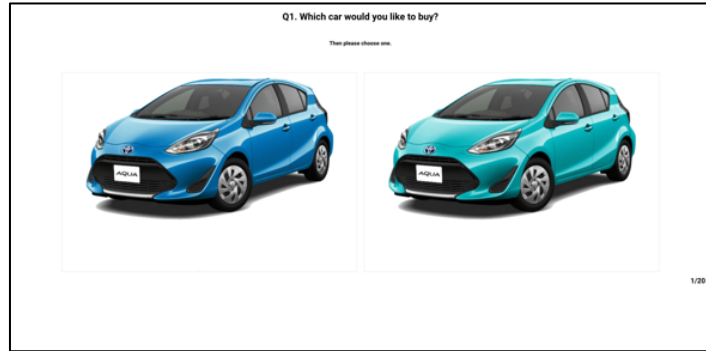
Yokoyama et al. [5] investigated the influence of the design of the progress bar displayed during the waiting time on the web screen on the participant's subsequent selection behavior. They found that a right-to-left animation and a progress bar on the upper side tended to maintain fairness in selection behavior. Focusing on a visual characteristic called pop-out, Hosoya et al. [6] implemented a digital signage-type vending machine and investigated how pop-outs affect participants. They found that participants were likelier to select products that had been popped out.

These studies suggest that various factors are involved in choice behavior, and that product package design significantly impacts the impression of a product and is an essential factor in choice behavior. In addition, studies on the Goldilocks effect and color have yet to be conducted. This study aims to clarify the influence of color on choice behavior when a person is given three choices.

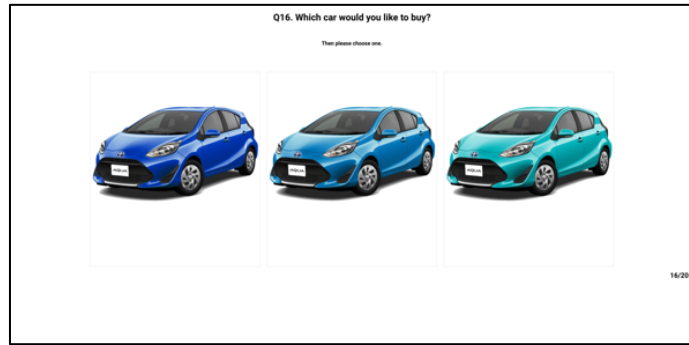
### 3 Experiments

#### 3.1 Outline of the Experiment

In this experiment, we investigate the influence of color on choice behavior based on the hypothesis that when a product is presented in two colors and an average color simultaneously in a three-choice scenario, the average color product is more likely to be chosen. To investigate the influence of color on choice behavior, we created an experimental system (Fig. 1 and Fig. 2) in which images of the same product, with only the color, changed, are presented in two or three choices, and conducted a large-scale experiment using *Yahoo! crowdsourcing* [7].



**Fig. 1.** An example of the screen during the presentation of two choices in the experiment.



**Fig. 2.** An example of the screen during the presentation of three choices in the experiment.


#### 3.2 Experimental Design

We designed experiments using various colors and products to show the relationship between color and selection behavior.

Specifically, we selected 10 product categories such as clothing, food and drink, electrical appliances, and household goods frequently selected in everyday life. Then, we prepared one product image in each product category and created two product

images in each category from the original image by changing the saturation and brightness. Table 1 shows the product images in each category. In each category, there are three product images.

**Table 1.** Examples of selection targets in each product category.

	hue+0 x	hue+30 average	hue+60 y		brightness+70 x	brightness+0 average	brightness-70 y
<b>Desktop PC</b>				<b>Mask</b>			
	hue+0 x	hue+20 average	hue+40 y		hue+0 x	hue-15 average	hue-30 y
<b>Car</b>				<b>Men's Hoodies</b>			
	chroma+0 x	chroma-50 average	chroma-100 y		(R,G,B)= (223,228,232) x	(R,G,B)= (159,190,216) average	(R,G,B)= (95,152,200) y
<b>Pants</b>				<b>Shirt</b>			
	hue+0 x	hue+25 average	hue+50 y		hue+0 x	hue+40 average	hue+80 y
<b>Ice cream</b>				<b>Women's Hoodies</b>			
	hue+35 x	hue+0 average	hue-35 y		hue+0 x	hue-30 average	hue-60 y
<b>Drink</b>				<b>Cups</b>			

We studied the difference in the selection rate of the average color product in two choices and in three choices to test our hypothesis. In the experiment, our system selected five product categories randomly for the three-choice task, and the other five for the two-choice task. Since three combinations of two choices can be created from three types of color images, the number of questions is 5 three choices and 15 two choices, for a total of 20 questions.

We implemented the experimental system using Vue.js, a JavaScript framework.

### 3.3 Experimental Procedure

A participant first accessed the experiment system page through *Yahoo! crowdsourcing* in this experiment. The first page of the experiment system explained the experiment. At that time, a unique 16-digit alphanumeric and lower-case ID was generated for each participant. The survey procedure and precautions were confirmed on the page explaining the experiment, and the participants were asked to check a check box. The instructions included the following: enlarge the window size, experiment on a PC, do not press the reload button, and use a browser other than Internet Explorer. In addition, the explanation page also asked participants to select their gender and age. The experiment could only be started if all the checkboxes were checked. Note that the

experimental system allowed access only from PCs, and the browsers were limited to Google Chrome, Mozilla Firefox, and Apple Safari.

When the participant moved to the experimental screen, he/she was given three seconds to compare the products for each question. Afterward, the participant clicked on the button displayed and selected a product. This was one trial. The purpose of presenting the button on each trial was to reset the mouse cursor position by having the participant click the button, thereby eliminating the influence of the mouse cursor position at the start of the trial as much as possible. The choices on the experimental screen consist of three two-choice questions and one three-choice question, repeated five times for a total of 20 trials. For each trial, we recorded the selected image, the selected image's position, the selection time, the number of clicks, the window width, window height, and so on.

After 20 trials of the experiment were completed, the participant was taken to a questionnaire screen. On the questionnaire screen, there were two columns: one for selecting their favorite color and the other for writing about what was problematic in the experiment and whether or not there were any errors.

In a crowdsourcing experiment, participants might give inauthentic responses. To reduce such responses, we blocked 1,312 inappropriate participants from past experiments in advance. In addition, we extracted the data from participants who gave inauthentic or inappropriate responses from the acquired body of data. In this experiment, we extracted inauthentic responses and inappropriate participants by referring to the selection time, window size, and the number of clicks.

## 4 Results

In this experiment, we recruited 1,000 participants (500 females and 500 males). In total, 102 participants (42 females and 60 males) gave inauthentic or inappropriate responses. Therefore, we analyzed the data of 898 participants (458 females and 440 males), excluding the 102 inappropriate participants.

### 4.1 Results and Analysis of the Overall Selection Rate

First, in the free description section of the questionnaire conducted in this experiment, there was a group of options in which there were multiple opinions that the colors of the products were similar or indistinguishable. Therefore, we will refer to the set of colors that were not easily distinguishable as similar colors, and to one color that is different from the two similar colors as dissimilar colors. In addition, the four choices (ice cream, drink, women's hoodies, and cup) that include similar and dissimilar colors are denoted as "Choice Group Pop-out," and the other six choices that are distinguishable are denoted as "Choice Group Normal."

Table 2 shows the selection percentage of each item in the "Choice Group Normal." In Table 2, the blue text indicates a decrease in the percentage of the three choices, and the red text indicates an increase. The results show that the percentage of average color choices increased for pants and men's hoodies while it decreased for the other items.

The average color selection rate for "Choice Group Normal" was 38.93% when two choices were presented, and 36.01% when three choices were presented, indicating that average color products were not more likely to be selected when three choices were presented. Table 3 shows the selection rate of each item in the "Choice Group Pop-out." In Table 3, the choice with an orange background is dissimilar, and the other two are similar colors. In Table 3, the selection rate of the average color choice was lower for all items when three choices were presented than when two choices were presented. However, the selection rate of the dissimilar color choice increased significantly in the three-choice presentation compared to the two-choice presentation.

**Table 2.** Selection rate of each item in "Choice Group Normal."

Category		x	average	y
Desktop PC	two choices	29.33	42.67	28.00
	three choices	38.89	39.58	21.53
Car	two choices	21.19	39.28	39.53
	three choices	18.57	35.00	46.63
Pants	two choices	44.69	37.28	18.02
	three choices	37.31	40.30	22.39
Mask	two choices	44.19	39.14	16.67
	three choices	46.72	36.50	16.79
Men's Hoodies	two choices	37.83	41.13	21.04
	three choices	32.03	41.41	26.56
Shirt	two choices	44.36	34.07	21.57
	three choices	47.37	23.31	29.32
Average	two choices	36.93	38.93	24.14
	three choices	36.82	36.01	27.17

**Table 3.** Selection rate of each item in "Choice Group Pop-out."

Category		x	average	y
Ice cream	two choices	17.20	37.90	44.89
	three choices	17.93	29.66	52.41
Drink	two choices	29.85	32.03	38.13
	three choices	39.66	21.55	38.79
Women's Hoodies	two choices	43.66	38.03	18.31
	three choices	61.42	19.69	18.90
Cups	two choices	43.75	31.77	24.48
	three choices	56.03	20.57	23.40
Average	two choices	33.62	34.93	31.45
	three choices	43.76	22.87	33.38

#### 4.2 Results and Analysis of Selection Rates by Gender

Abramov et al. [9] showed that there might be differences in the way males and females see and perceive color. Therefore, we analyzed the results for each gender, assuming that each gender sees and perceives colors differently.

Table 4 shows the results of the selection rates for each item in the "Choice Group Normal" for females. Comparing the average color selection rates for the two-choice group and the three-choice group, the average color selection rates for the three-choice group were higher than those for the two-choice group for five of the six items, except the shirt. The mean average color choice rate for the two-choice group was 39.52%, while the mean average color choice rate for the three-choice group was 42.92%, indicating that females were more likely to select an average color item when presented with three choices than when presented with two choices. The  $\chi^2$  test on the total number of choices for all items in "Choice Group Normal" with a significance level of 5% confirmed a significant difference in the number of choices in terms of whether or not respondents chose average colors ( $\chi^2(1) = 4.06, p = .044$ ).

Table 5 shows the results of the selection rate for each item in the "Choice Group Pop-out" for females. The results for "Choice Group Pop-out" were similar to those shown in Table 3, with the average color choices having a lower selection rate when presented with three choices than when presented with two. Table 5 shows that the selection rate for the three choices was much higher than that for the two choices for the dissimilar-colored choice with an orange background. The  $\chi^2$  test on the total number of selections for all items in "Choice Group Pop-out" with a significance level of 5% confirmed a significant difference in the number of selections for the dissimilar color ( $\chi^2(1) = 35.65, p < .001$ ).

**Table 4.** Selection rate of each item in "Choice Group Normal" for females.

Category		x	average	y
Desktop PC	two choices	32.18	42.96	24.86
	three choices	37.17	46.02	16.81
Car	two choices	28.71	38.91	32.38
	three choices	23.94	45.07	30.99
Pants	two choices	43.14	37.25	19.61
	three choices	40.08	40.51	19.41
Mask	two choices	42.94	42.80	14.27
	three choices	40.93	48.84	10.23
Men's Hoodies	two choices	37.31	40.47	22.22
	three choices	35.35	42.79	21.86
Shirt	two choices	44.60	34.70	20.70
	three choices	43.93	34.31	21.76
Average	two choices	38.15	39.52	22.34
	three choices	36.90	42.92	20.18

**Table 5.** Selection rate of each item in "Choice Group Pop-out" for females.

Category		x	average	y
Ice cream	two choices	16.42	36.52	47.07
	three choices	21.62	22.01	56.37
Drink	two choices	36.10	31.30	32.61
	three choices	47.60	23.58	28.82
Women's Hoodies	two choices	37.76	38.59	23.65
	three choices	52.53	23.50	23.96
Cups	two choices	44.95	34.40	20.64
	three choices	52.92	27.92	19.17
Average	two choices	33.81	35.20	30.99
	three choices	43.67	24.25	32.08

Table 6 shows the results of the selection rate of each item for males in "Choice Group Normal." Unlike females, males showed a lower average color selection rate when presented with three choices than when presented with two choices. In addition, males' average color selection rates were lower when they were presented with three choices than when they were presented with two choices for all six items, indicating that males were less likely to select average colors when presented with three choices than when presented with two choices. Similar to the results for females, the  $\chi^2$  test confirmed a significant difference in the number of choices for the choice of average colors ( $\chi^2(1) = 11.22$ ,  $p < .001$ ).

Table 7 shows the results of the selection rates for each item in "Choice Group Pop-out" for males. As in Tables 3 and 5, the selection rate of the average color choice was lower in the three-choice group than in the two-choice group. In addition, the selection rate of the dissimilar color choice was much higher when the three choices were presented than when the two choices were presented. Similar to the results for females, the  $\chi^2$  test showed that there was a significant difference in the number of choices for the dissimilar color among males ( $\chi^2(1) = 65.47$ ,  $p < .001$ ).



**Table 6.** Selection rate of each item in "Choice Group Normal" for all males and males.

Category		x	average	y
Desktop PC	two choices	26.18	40.98	32.85
	three choices	32.34	38.72	28.94
Car	two choices	16.90	37.98	45.12
	three choices	15.11	34.67	50.22
Pants	two choices	43.08	36.44	20.48
	three choices	43.14	30.88	25.98
Mask	two choices	39.29	36.23	24.48
	three choices	41.20	31.76	27.04
Men's Hoodies	two choices	34.22	38.64	27.14
	three choices	35.98	37.85	26.17
Shirt	two choices	39.62	33.81	26.57
	three choices	47.81	19.30	32.89
Average	two choices	33.22	37.35	29.44
	three choices	35.93	32.20	31.71

**Table 7.** Selection rate of each item in "Choice Group Pop-out" for all males and males.

Category		x	average	y
Ice cream	two choices	23.15	37.96	38.89
	three choices	20.98	30.80	48.21
Drink	two choices	33.33	28.99	37.68
	three choices	44.29	20.48	35.24
Women's Hoodies	two choices	54.06	35.51	10.43
	three choices	76.19	14.29	9.52
Cups	two choices	38.71	33.33	27.95
	three choices	60.37	12.90	26.73
Average	two choices	37.31	33.95	28.74
	three choices	50.46	19.62	29.93

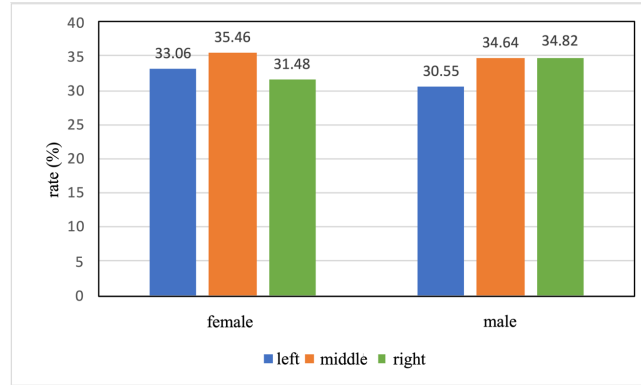
These results support the hypothesis when limited to females. In addition, it was found that both males and females tended to select the non-similar color choice when there was a non-similar color choice among the similar color choices. When focusing on the selection rate of dissimilar colors, the selection rate of females was 41.47% when presented with two choices and 52.36% when presented with three choices, and the selection of males, when presented with two choices, was 41.25% and 57.27% when presented with three choices., the rate of increase was slightly higher in males than in females.

### 4.3 Results and Analysis for Selection Position

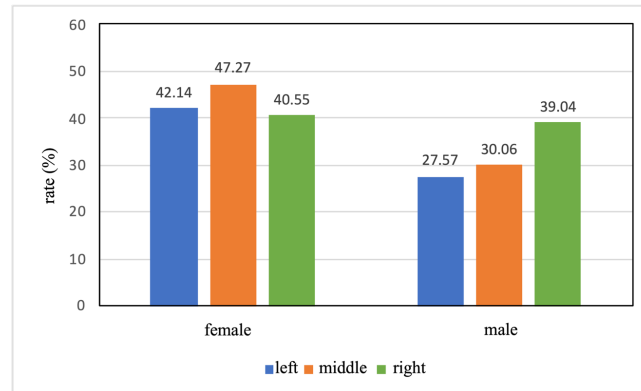
Fig. 4 shows the average selection rate by gender for each position when the three choices were presented. Fig. 4 shows that females tended to select the middle choice. Males tended to select the choice in the middle and on the right, similar to the results of Wilson et al. [7].

We also analyzed the average choice rate of average color according to the position of the average color when the three choices were presented (see Fig. 5). This figure shows that females tended to select the most average color choice when the color choice was presented in the middle. On the other hand, males tended to select the average color choice when the average color choice was presented on the right.

Comparing Figs. 4 and 5, we can see that females tended to select the average color choice more than the non-average color choice in all positions. Males tended not to select the average color choice when it was presented on the left or in the middle but were more likely to select it when it was presented on the right.



**Fig. 4.** Average selection rate by gender for each position in the three choices.



**Fig. 5.** Average color selection rate per average color presentation position.

## 5 Discussion

This experiment showed that the results for the average color choice rate for both genders as a whole were different from our hypothesis. However, we found that the dissimilar color tended to be selected more often in "Choice Group Pop-out," in which the average color was similar to one of the two colors in the three choices. This result may be similar to the induction of choice by pop-outs, as revealed by Hosoya et al. [6]. We believe that the presence of dissimilar-colored products among similar-colored products influences selection behavior and distorts fairness in the same way as pop-outs. The effect of dissimilar colors on selection behavior was smaller for females than for males. This result suggests that females can discriminate finer color differences better than males.

The results for both genders as a whole contradicted the hypothesis, but when only females, they tended to choose average colors. The results also showed that males tended to avoid the average colors. These results suggest that the presence of average color distorts the fairness of the selection behavior. The difference between females and males may be that males and females see or perceive colors differently, as found by Abramov et al. [9].

This experiment showed that when presented with three choices, females were more likely to select the choice in the center, while males were more likely to select the choice on the right. This suggests that females are more likely to be influenced by center bias, while males are more likely to be influenced by right-side bias. In addition, females were more likely to select the average color, regardless of where it was displayed, whereas males were more likely to select the average color only when it was placed on the right side. These results suggest that placing the average color on the right side can induce males to select the average color choice and significantly reduces the gender difference in choices that include average colors.

## 6 Conclusion

In this study, we conducted two-choice and three-choice experiments to test the hypothesis that when two colors and their average color product are presented simultaneously in a three-choice scenario, the average color product tends to be selected more often. Specifically, we experimented using *Yahoo! Crowdsourcing*, by presenting two colors and their average colors together, and presenting products in two of those three colors were presented together.

The analysis of this experiment showed that within "Choice Group Normal," there was a significant difference in females' average color choice rate when presented with two choices and when presented with three choices, and that females tended to choose average colors when presented with three choices, which was in line with the hypothesis. On the other hand, there was a significant difference in the rate with which males chose average colors when presented with two choices and when presented with three choices. However, males tended to avoid choosing average colors when presented with three choices, which differed from the hypothesized result. We hypothesized that

this difference between females and males was due to the differences in the way they see, feel, and perceive colors depending on their gender. We plan to verify this point by conducting further experiments.

In the case of “Choice Group Pop-out,” where the average color was similar to one of the two other colors among the three choices, both males and females tended to choose the dissimilar color. However, this result differed from the hypothesis that they would be more likely to choose the average color. This result may be similar to the induction of choice by pop-out, as shown by Hosoya et al. [6]. The analysis of the selection position revealed that placing the average color choice on the right side decreases the difference in the selection rate between male and female participants.

In this experiment, we showed that the presence of average color affects the choice behavior in a three-choice task. However, the effects of average color on choice behavior differed between males and females. In the future, we plan to conduct a detailed investigation of the reasons for the differences in the effects and to study the construction of a system to maintain the fairness of choice behavior based on the results obtained in this experiment.

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