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How can health look tasty? Effects of packaging color saturation on beverage health and taste expectations depend on color match

Katharina Steiner, Sonja Kunz and Arnd Florack
Department of Occupational, Economic, and Social Psychology, Faculty of Psychology, University of Vienna, Vienna, Austria

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Abstract

Purpose – It is of significant interest to marketers to identify visual product cues that signal high tastiness and healthiness, as both characteristics are of substantial importance to consumers. One such cue is the saturation of the packaging color. However, past studies found diverging effects of packaging color saturation on consumer tastiness and healthiness judgments. In this study, we investigated a possible moderator of the saturation effect: the match between the primary packaging color and the color of the main product ingredient.

Design/methodology/approach – In two online studies, participants viewed pictures of fruit juices (Study 1) and hydration drinks (Study 2). For each product, participants rated the expected taste and healthiness. We manipulated the color saturation and color match of the product pictures.

Findings – When the packaging color matched the main ingredient (e.g. orange juice in an orange package), consumers expected products in normal versus low saturated packages to be healthier and tastier. When the packaging color did not match the color of the main ingredient (e.g. orange juice in a red package), the positive effects of saturation on health and taste were reduced or even disappeared.

Practical implications – The results suggest that managers can optimize product health and taste perceptions by using moderately saturated packaging colors, particularly when the packaging color aligns with the main ingredient's color.

Originality/value – Our research offers a possible explanation for diverging effects of color saturation on product judgments. We show that whether and to what extend color saturation affects health and taste judgments might depend on the match between the packaging and ingredient color.

Keywords Packaging color, Color saturation, Color match, Tastiness, Healthiness

Paper type Research paper

1. Introduction

Taste and health play an important role in consumer product evaluation and choice (Giezenaar *et al.*, 2024; Hallez *et al.*, 2023; Johansen *et al.*, 2011; Mai *et al.*, 2014; Petit *et al.*, 2024; Steptoe *et al.*, 1995). Several studies have demonstrated that taste is one of the most important factors influencing consumer choice and has a significant impact on purchase decisions (Buhrau and Ozturk, 2018; Hallez *et al.*, 2023; Honkanen and Frewer, 2009; Kourouniotis *et al.*, 2016). Furthermore, the importance of health is on the rise as an increasing number of consumers pursue a healthy lifestyle (Poinski, 2020). Consequently, it is advantageous for marketers to understand the factors that enhance the appeal of a product both in terms of taste and health benefits. One such factor is package color, which has the potential to positively influence consumer expectations of taste and health (Hallez *et al.*, 2023; Kunz *et al.*, 2020; Mai *et al.*, 2016; Tijssen *et al.*, 2017).

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Several studies have shown that particularly color saturation of a product's packaging can impact consumer expectations of taste and health (Kunz *et al.*, 2020; Mai *et al.*, 2016; Mead and Richerson, 2018; Tijssen *et al.*, 2017). Nevertheless, research on the combined effects of color saturation on taste and health expectations is limited (Steiner and Florack, 2023). One recent exception is a study by Kunz *et al.* (2020), which suggests that color saturation influences both health and taste judgments. The authors argue that differences in color saturation help people identify ripe and fresh fruits and vegetables, while low color saturation signals that the food items are beginning to spoil.

Findings of other studies suggest that the mechanisms behind color saturation are more complex and that saturation can have opposing effects on health and taste judgments (Mai *et al.*, 2016; Mead and Richerson, 2018; Tijssen *et al.*, 2017). One explanation is that less saturated colors appear lighter and signal health, but not taste (Steiner and Florack, 2023). For example, Mai *et al.* (2016) found that packaging with light colors in comparison to darker colors increased health perception but decreased taste expectation across various product categories, such as cream cheese or cereal bars.

Findings from experimental studies support two theoretical accounts for the effects of color saturation. The first account suggests that reduced color saturation signals lower quality or freshness of the food product, which is relevant for both health and taste (Kunz *et al.*, 2020). The second account suggests that reduced saturation stands for reduced content, such as reduced fat or calories (Karnal *et al.*, 2016; Mai *et al.*, 2016). While reduced fat or calories might be beneficial for health, consumers might associate it with a loss of taste. Although both accounts are compelling, further research is necessary to better understand when each account predicts consumer responses.

One potential explanation for the discrepant findings is that the color saturation-freshness association is only informative for health and taste when the package color matches the color of the main ingredient. When the color of the packaging differs from that of the main ingredient, for instance when milk is packaged in a blue-colored container, consumers may rely on alternative cues to assess the health and taste qualities of the food product.

The present research, therefore, examines whether the match between the dominant color of beverage packaging and the main flavor-giving ingredient moderates the effects of color saturation on the expected health and taste of beverages. Building upon the theoretical account established by Kunz *et al.* (2020), we hypothesize that for colors that match the main ingredient, normal saturation levels increase health and taste expectations, whereas low saturation levels reduce health and taste expectations. Moreover, we expect that the influence of color saturation on health and taste judgments will be reduced when the primary color of the beverage packaging does not match the color of the main ingredient. We define the color of the main ingredient as the color of the main component of the drink, not the beverage itself. For example, the main ingredient of orange juice is oranges, which are orange, whereas the orange juice itself is yellow. According to our definition, orange packaging matches the color of the main ingredient, whereas yellow packaging does not.

2. Conceptual background

The color attributes of food packages exert a considerable influence on consumers' judgments of the health and taste of food products (Spence, 2015; Spence *et al.*, 2022; Spence and Van Doorn, 2022). The attributes of color can influence consumers' sensory evaluations and expectations even before they taste the product (Tijssen *et al.*, 2017). Table 1 provides an overview of the current literature on the influence of hue and saturation on consumer taste and health perception. The color match between the packaging color and the main ingredient of a product has not been systematically varied in previous studies.

One aspect of color that can influence both health and taste judgments of consumers is hue, which represents the type of color such as red, yellow, or blue. Color hue has a significant impact on consumer taste expectations and is more dominant than other color attributes, such

Table 1. Review of current literature on the influence of color on health and taste perception

Reference	Key findings	Stimuli	Color match
Hallez *et al.* (2023)	- Cool packaging colors (green/blue) increased health perception - Warm packaging colors (red/yellow) increased taste perception only in the beverage category, not in snacks	- Product categories: four beverages (i.e. an energy drink, a sports drink, a sparkling water drink and a cola drink) and four sweet and savory snacks (i.e. a chocolate bar, a nut mix, a bag of crisps and a crispy fruit snack) - Color manipulation: cool (blue/green) vs. warm (red/yellow) packaging colors	no color match
Huang and Lu (2016)	- Blue packages were perceived healthier than red packages. - Utilitarian products (yogurt or milk) were more influenced by package color than hedonic products (ice cream or chips)	- Product categories: cereal, yogurt, milk, potato chips, ice cream, iced tea - Packaging colors: blue vs. red	no color match
Kunz *et al.* (2020)	- Increased color saturation improved healthiness and tastiness ratings. - Saturation affected tastiness more than healthiness perceptions	- Product categories: 20 nonalcoholic drinks (juices and smoothies) - Color manipulation: high vs. low saturation	color match not identifiable
Mai *et al.* (2016), Study 1a & 1b	- Light vs. regular colored products were perceived as healthier - Regular vs. light colored cereal bar was perceived as tastier (Study 1b)	- Product category: cereal bar, pizza, chocolate, yoghurt, cream cheese, potato chips, fruit bar, juice - Color manipulation: high vs. regular saturation	color match not identifiable
Mai *et al.* (2016), Study 2-3a & 4	- Light vs. regular colored products were perceived as less tasty - Light vs. regular colored products were perceived as healthier - Health consciousness moderated consumer responses to packaging color	- Product categories: pizza, chocolate, yoghurt, cream cheese, potato chips, juice - Color manipulation: light vs. regular color saturation	no color match
Mai *et al.* (2016), Study 3b	- Light-colored product was perceived as healthier as regular colored product - No negative impact on taste perception was observed for light versus regular colored packaging	- Product category: fruit bar - Color manipulation: high vs. regular saturation	color match
Marques Da Rosa *et al.* (2019)	- Red-to-yellow and blue-to-green packaging were preferred over grayscale packaging. - Participants perceived cookies in red-yellow packaging as healthier than those in blue-green packaging	- Product categories: buttery and cereal cookies - Color manipulation: blue-to-green vs. red-to-yellow	color match not identifiable

(*continued*)

Table 1. Continued

Reference	Key findings	Stimuli	Color match
Mead and Richerson (2018)	- Products in high vs. low packaging were perceived as less healthy - Conceptual fluency mediated this perception. - Subjective nutritional knowledge weakened the effect, while restrained eating behavior strengthened the effect	- Product categories: potato chips and nutrition bars - Color manipulation: high vs. low color saturation, multiple color hues	color match not identifiable
Tijssen *et al.* (2017)	- Warmer, more saturated colors enhanced attractiveness and sensory evaluation - Less saturated packagings with cool colors (blue hue) were perceived as healthier but less attractive	- Product categories: low-sugar dairy drinks and low-fat sausages - Color manipulation: blue, purple, red, green color hue, high vs. low color saturation, high vs. low color brightness	color match not identifiable

Source(s): Authors' work

as saturation (Gambetti and Han, 2022; Motoki *et al.*, 2021). Hue can be determined by the wavelength of light that reflects off the surface of the food product. However, the perception of color is an individual experience, and consumers often perceive the color of a package to be the same even when lighting conditions change, and the actual reflection of wavelength varies, a phenomenon known as color constancy (Foster, 2011).

The perceived hue exerts a significant influence on both health and taste judgments. For instance, the color blue is associated with aspects of nature, such as the blue sky or clean water (Palmer and Schloss, 2010). As healthiness is related to naturalness, these colors might signal healthiness. Also, more abstract meanings are associated with colors that indirectly imply healthiness. For instance, the color blue is associated with desirable states such as trust or peace (Huang and Lu, 2016). Evidence for color hue effects on health perception was provided by Huang and Lu (2016). The researchers found that utilitarian products, such as milk or yogurt, were perceived as healthier when packaged in blue than when packaged in red.

Besides the impact on health expectations, the hue of a food package can also influence taste assessments. For instance, consumers are sometimes less able to identify the flavor of a beverage when the beverage's color is altered to a hue associated with a different flavor (Zampini *et al.*, 2007). Furthermore, the color has an effect on the degree of enjoyment experienced by consumers, in particular when the color does not match the flavor (DuBose *et al.*, 1980).

In addition to hue, color saturation affects consumers' perceptions of the health and expected taste of products (Kunz *et al.*, 2020; Mead and Richerson, 2018; Tijssen *et al.*, 2017). Color saturation is a subjective experience, meaning that individuals perceive a highly saturated color as pure or true. Low saturation indicates an experience that the true color of an object is fading. Technically, lower saturation means that a color is mixed with other colors. As mentioned in the introduction, the effects of color saturation on the expected healthfulness of a food are mixed.

On the one hand, researchers have observed positive effects of saturation on both healthiness and tastiness judgments. In one study, Kunz *et al.* (2020) presented participants with a series of pictures of beverages. The researchers observed that the beverages were expected to be healthier and tastier when the images' color saturation was increased rather than reduced. In addition, the highly saturated packages were perceived as fresher, and this perception of product freshness was found to mediate the effect of color saturation on the

expected tastiness and healthiness of the beverages. The results by Kunz *et al.* (2020) are consistent with the theoretical account of a saturation-freshness relationship. From an evolutionary point of view, it is advantageous to be able to distinguish fruits with the highest nutritional content from rotten fruits. Color perception is indeed thought to support this differentiation between edible and inedible foods (Sánchez-Solano *et al.*, 2020). Rotten fruit loses its "true color" and as a result, its color is less saturated. It is possible that the same mechanism that helped human ancestors identify edible food is still used by today's consumers to evaluate packaged food. Therefore, we expect a positive influence of color saturation on health and taste expectations in the present study.

H1. Consumers expect a product to be healthier (*H1a*) and tastier (*H1b*) when a food packaging color has a normal saturation than when it has a low saturation.

On the other hand, other studies have reported contradictory results regarding the effects of color saturation on health expectations. For instance, Mai *et al.* (2016) found across different categories of packaged foods, such as cream cheese, cereal bars, and potato chips, that regular saturation levels in packaging colors were associated with better taste expectations but decreased health judgments. These results were replicated by Mead and Richerson (2018). In their study, consumers expected potato chips and snack bars in highly saturated packages to be tastier, but less healthy than in low saturated packages. Similarly, Tijssen *et al.* (2017) observed that yogurt drinks and sausages in vibrant and highly saturated package colors compared with less vibrant and lowly saturated package colors were expected to have a stronger flavor, but to be less healthy.

Importantly, the positive link between saturation and taste expectation in these studies cannot be explained by the saturation-freshness association because this would imply positive effects of saturation on both health and taste judgments. However, the opposing effects of saturation on health and taste judgments can be attributed to various alternative mechanisms.

First, consumers may perceive colors with lower saturation as being lighter, which may lead to the impression that the products feel less heavy and contain less sugar or fat (Mai *et al.*, 2016), ingredients which are often associated with tastiness, but considered less healthy. If consumers believe that they are missing, they might conclude that a product is healthier, but also less tasty. Second, consumers may have learned that marketers use less saturated colors to signal the reduction of fat or sugar (Steiner and Florack, 2023). Consumers might access this knowledge to infer that a product in less saturated colors is healthier, because unhealthy ingredients are reduced, but less tasty, because ingredients related to taste are reduced. Third, saturation might send signals which can indirectly influence health and taste judgments. Researchers have proposed that saturated colors are associated with excitement and enjoyment (Labrecque *et al.*, 2013). According to a prevalent belief rooted in the Protestant work ethic, highly valued societal goals, like a healthy lifestyle, are incompatible with enjoyment (Raghunathan *et al.*, 2006). Hence, the dominant associations between color saturation and enjoyment may inhibit a strong health assessment (Mead and Richerson, 2018). The various mechanisms predict that consumers rely on saturation as a signal with opposing implications for health and taste. Taken together, whereas past research found exclusively positive effects of saturation on taste, the evidence on effects of saturation on health are mixed.

One factor that may contribute to a better understanding of the divergent effects of saturation on health judgments reported in the literature is whether or not the primary color of the food packaging matches the color of a product's main ingredient. Based on the cross-modal correspondence phenomenon (Spence, 2011), we hypothesize that color saturation has similar effects on health and taste judgments especially when the packaging color matches the color of a product's main ingredient. When the package color does not match the ingredient, we expect that other signals conveyed by color saturation are more influential in forming expectations about health and taste. In this case, we propose that saturation might have a weaker effect on health and taste expectations.

The phenomenon of cross-modal correspondence (Spence, 2011) posits that associations between different sensory modalities, such as sight and smell, are formed through repeated experiences of these modalities in combination. For example, consumers repeatedly observe that the color attributes of food change in the process of fruit ripening and spoilage, and thus form associations of colors with taste at the different stages of ripening and spoilage (Maga, 1974; Tu *et al.*, 2016). According to the cross-modal correspondence phenomenon, such color associations can then trigger the corresponding taste expectations when consumers see the color of the food. The findings of several studies support cross-modal correspondences, specifically the assumption that learned color associations influence expectations. Durlach and Zellner (2003), for example, presented consumers beverages with different color-flavor combinations. The researchers found that consumers expected a lemon flavored drink with no color or in yellow to be more refreshing than in brown color (Durlach and Zellner, 2003). Tu *et al.* (2016) observed that the color of the plate influenced expectations about the spiciness of food. For instance, consumers expected food to be spicier when presented on red plates than when presented on green plates.

The cross-modal correspondence phenomenon posits that a learned color association influences expectations about the qualities of food. It is plausible that color saturation may be part of such associations. However, we hypothesize that the meaning of saturation for food is linked to the color hue, for instance, to the specific color hue of a ripening or spoiling fruit. We therefore postulate that consumers are less likely to apply the link between saturation and freshness when the color of a food package does not match the color of the main ingredient.

H2. The positive effect of saturation on health (*H2a*) and taste (*H2b*) expectations will be stronger when the package color matches the color of the main ingredient than when it does not match the color.

3. Summary and outline of the present studies

The present research examined the influence of packaging color saturation on the expected healthiness and tastiness of a product and the moderating role of color match on this effect. To this end, we conducted two studies in which participants viewed fruit juices (Study 1) or hydration drinks (Study 2). We varied whether the products were packaged in normal or low saturated colors and whether the package color matched the color of a product's main ingredient (e.g. orange juice in an orange package) or not (e.g. orange juice in a red package). Participants rated the healthiness and tastiness of each product. We used fruit juices and hydration drinks to examine whether the predicted effects can be observed across two product categories with different levels of food processing (lower for fruit juices, higher for hydration drinks). The research was approved by the Departmental Review Board of the Department of Occupational, Economic, and Social Psychology at the University of Vienna (Approval number: 2023/S/004A).

4. Study 1: the influence of packaging color saturation and color match on consumer health and taste expectations of low-processed drinks

4.1 Method

4.1.1 Participants and design. Participants were recruited from Austria and Germany via the online research platform Prolific. Participants who did not give their consent to participate or failed an attention check at the beginning of the study were excluded *a priori*. The final sample consisted of 250 participants, 50.4% women and 48.0% men, 1.6% other genders, with a mean age of 29.06 ($SD = 7.53$). All participants indicated that German was their native language. This study employed a 2 (color saturation: low vs. normal) $\times$ 2 (color match: matched vs. not matched) $\times$ 3 (flavor: orange vs. mango vs. apple) within-subject design. The flavor was a random factor for which we had no hypotheses.

4.1.2 Procedure. Participants rated the healthiness and tastiness of juice package images, separately and in random order. On each trial, participants first viewed the juice package image alone for two seconds before having to rate the image while still viewing it. The healthiness and tastiness ratings were gathered in two separate rating blocks. In the first block, participants rated the healthiness of each fruit juice. In the second block, participants rated the tastiness of the same fruit juices in the same order as the healthiness. After rating all beverages on healthiness and tastiness, participants were asked to provide information regarding their demographic characteristics (e.g. age, gender, and nationality).

4.1.3 Materials. All participants viewed pictures of fruit juice packages in three different flavors (orange, mango and apple) that varied in color saturation (normal vs. −30% color saturation reduction) and color match (match vs. no match). This resulted in a total of 12 pictures per participant, which were presented in random order. The juice packages were designed to reflect the typical layout of a fruit juice package and included the brand logo, product name, and images of the fruit. In the color-match condition, the primary color of the package matched the color of the fruit that was the main ingredient of the juice, whereas in the no-match condition, a different color was used as primary package color. The following color hues were used in the matching condition: orange juice – orange, apple juice – red, mango juice – orange. In the non-matching condition, the following color hues were used: orange juice – red, apple juice – purple, mango juice - pink. Table A1 in the appendix shows the specific color parameters in each condition.

4.1.4 Measures. Participants had to rate the healthiness of each fruit juice on a 10-point scale (1 = *Very unhealthy*; 10 = *Very healthy*) by answering the following question: "How healthy would you rate this fruit juice based on its packaging?". Also, participants had to rate the tastiness on a 10-point scale (1 = *Does not taste good at all* to 10 = *Tastes very good*). The item to measure the expected tastiness was "How would you rate the taste of the fruit juice based on its packaging?". Table 2 depicts descriptive statistics of the dependent variables in Study 1.

4.1.5 Data analysis. Since the participants repeatedly rated multiple juice packages with varying background colors in terms of healthiness and tastiness, the evaluations are nested within participants and intercorrelated. To account for this, we used a linear mixed effects model analysis (Gałecki and Burzykowski, 2013; Maxwell and Delaney, 2004). All analyses were conducted at a significance level of $\alpha = 0.05$. We analyzed the data using R 4.3.2 (R Core Team, 2023), specifically the package nlme (Pinheiro *et al.*, 2016).

4.2 Results

4.2.1 The influence of color saturation, color match, and their interaction on expected healthiness of fruit juices. We hypothesized that products would be expected to be tastier and healthier when a normal vs. low saturated packaging color was used. We further hypothesized that the effect of saturation on healthiness and tastiness would be stronger for products with matching than non-matching colors. We calculated a linear mixed effect model predicting the healthiness ratings from color saturation, color match, and their interaction. Random intercepts for the participant and product flavor were included. The results of the analysis are presented in Table 3.

Most importantly and relevant for *H2a*, there was a significant interaction between color saturation and color match on healthiness, $F(1, 2{,}247) = 15.82$, $p < 0.001$. Pairwise comparisons based on estimated marginal means illustrate that in the color match condition, normal saturated products were rated as healthier ($M = 5.48$; $SD = 2.01$) than low saturated products ($M = 5.24$; $SD = 2.00$), $t(2{,}247) = 4.32$, $p < 0.001$. In the non-color match condition, no influence of color saturation on healthiness ratings could be observed $t(2{,}247) = -1.31$, $p = 0.19$. The results show that products in normal saturated packages are only rated as healthier than products in low saturated packages when the packaging color matches the color

Table 2. Descriptive Statistics Study 1: Influence on health and taste expectations of fruit juices

		M	*SD*
Mean healthiness by color saturation			
Saturation			
Normal saturation		5.16	2.02
Low saturation		5.08	1.98
Mean healthiness by color fit			
Color fit			
Color fit		5.36	2.01
No color fit		4.88	1.96
Fit	Saturation	*M*	*SD*
Mean Healthiness by color saturation and fit			
Color fit	Normal saturation	5.48	2.01
Color fit	Low saturation	5.24	2.00
No color fit	Normal saturation	4.84	1.97
No color fit	Low saturation	4.91	1.95
		M	*SD*
Mean tastiness by color saturation			
Saturation			
Normal saturation		6.18	2.11
Low saturation		5.37	2.05
Mean tastiness by color fit			
Fit			
Color fit		5.96	2.18
No color fit		5.59	2.03
Fit	Saturation	*M*	*SD*
Mean tastiness by color saturation and fit			
Color fit	Normal saturation	6.57	2.10
Color fit	Low saturation	5.35	2.09
No color fit	Normal saturation	5.79	2.05
No color fit	Low saturation	5.40	2.00

Source(s): Authors' work

of a product's main ingredient. In addition, main effects of color saturation, $F(1, 2{,}247) = 4.53$, $p = 0.03$, and color match, $F(1, 2{,}247) = 160.38$, $p < 0.001$, were also significant.

4.2.2 The influence of color saturation, color match, and their interaction on expected tastiness of fruit juices. Another linear mixed effect model was calculated with taste rating as the dependent variable and packaging color saturation, color match, and their interaction as fixed effects. Participant and product flavor were included as random intercepts. This time, we wanted to investigate whether packaging color saturation influences taste ratings and whether this relationship is moderated by packaging color match. The results of this analysis are shown in Table 4.

Again, we found a significant interaction between color saturation and color match (H2b), $F(1, 2{,}247) = 74.99$, $p < 0.001$. We ran pairwise comparisons of estimated marginal means

Table 3. Results of the LME model testing the effects of color saturation, color match, and their interaction on healthiness ratings of fruit juices

Predictors	$F(1, 2{,}247)$	p
Intercept	2818.31	<0.001
Color saturation	4.53	0.03
Color match	160.38	<0.001
Color saturation x color match	15.82	<0.001
Random effects		
σ^2		1.09
$\tau_{00\ \text{product}}$		1.39
$\tau_{00\ \text{id}}$		0.95
N_{product}		3
N_{id}		250
Observations		3,000
Marginal R^2		0.057

Source(s): Authors' work

Table 4. Results of the LME model testing the effects of color saturation, color match, and their interaction on tastiness ratings of fruit juices

Predictors	$F(1, 2{,}247)$	p
Intercept	5118.79	<0.001
Color saturation	286.96	<0.001
Color match	58.94	<0.001
Color saturation × color match	74.99	<0.001
Random effects		
σ^2		1.69
$\tau_{00\ \text{product}}$		0.98
$\tau_{00\ \text{id}}$		1.26
N_{product}		3
N_{id}		250
Observations		3,000
Marginal R^2		0.123

Source(s): Authors' work

between saturation conditions within each color match condition. In the color match condition, participants rated normal saturated packages as significantly tastier ($M = 6.57$; $SD = 2.10$) than low saturated packages ($M = 5.35$; $SD = 2.09$), $t(2{,}247) = 18.10$, $p < 0.001$. Also in the non-color match condition, normal saturated packages were rated as tastier ($M = 5.79$; $SD = 2.05$) than low saturated packages ($M = 5.40$; $SD = 2.00$), but the difference was smaller, $t(2{,}247) = 5.86$, $p < 0.001$. The results demonstrate that products in normal saturated packages are expected to be tastier than products in low saturated packages, especially when the packaging color matches the color of a product's main ingredient. In addition, we again found significant main effects of color saturation, $F(1, 2{,}247) = 286.96$, $p < 0.001$, and color match, $F(1, 2{,}247) = 58.94$, $p < 0.001$.

4.3 Discussion

Whereas previous research consistently found positive effects of saturation on taste judgments, it was not clear whether and when color saturation has positive or negative effects on health judgments. Therefore, Study 1 examined the match between the primary package color and the main ingredient as a possible moderator of this effect. The study replicated previous research based on the freshness-healthiness/tastiness relationship (Kunz *et al.*, 2020). We found that normal saturation of the primary package color led to higher health and taste expectations. However, the positive effect of saturation was reduced for taste judgments and not present for health judgments, when the package color did not match the main ingredient. Thus, the present research is consistent with the expectations we derived from the cross-modal correspondence principle. Color saturation as a cue is dependent on hue. We suppose that the meaning of saturation is learned in conjunction with the hue, which is repeatedly paired with the taste of the beverages.

An important limitation of Study 1 is, however, that we used a category of beverages (juices) for which sugar or fat-reduced alternatives differentiated by lighter packaging colors are not commonly available. More importantly, fruit juices are less processed than many other beverages. For more processed beverages, the freshness-healthiness/tastiness link might be less relevant, and consumers might rely to a lesser extent on color associations to infer product taste. Therefore, Study 2 aimed to strengthen the findings of Study 1, by replicating the procedure with another, more processed product category (hydration drinks).

5. Study 2: influence of packaging color saturation and color match on consumer health and taste expectations of high-processed drinks

In Study 2, we investigated the influence of color saturation on consumers' expectations of healthiness and tastiness and the moderating role of color match for the product category hydration drinks. Participants were asked to rate the healthiness and tastiness of hydration drinks that differed in color saturation and color match. We have pre-registered Study 2 on aspredicted.org. The preregistration documents are available at https://aspredicted.org/P58_K8B.

5.1 Method

5.1.1 Participants and design. We again used the online research platform Prolific to recruit participants from Austria and Germany whose native language was German. Participants who did not consent to participate or failed an attention check were again excluded *a priori*. The final sample consisted of 398 participants, 47.24% women, 48.99% men, 3.77% other genders, with a mean age of 28.94 (SD = 7.78) and a mean body mass index (BMI) of 24.63 (SD = 4.66). Study 2 employed a 2 (saturation: low vs. normal) x 2 (color match: matched vs. not matched) x 3 (flavor: orange vs. mango vs. apple) within-subject design. The flavor was a random factor for which we had no hypotheses.

5.1.2 Procedure and measures. The procedure and measures were identical to Study 1, except that participants rated the healthiness and tastiness of pictures of hydration drinks instead of fruit juices. Table 5 depicts descriptive statistics of the dependent variables in Study 2.

5.1.3 Materials. We created artificial hydration drink packages with a brand logo, flavor description, but unlike the stimuli used in Study 1, no images of the flavor-giving fruit. The flavor descriptions (orange, mango, apple), hues (match vs. no match), and saturation (normal vs. low) were identical to those used in Study 1 to ensure comparability of results. Again, the specific color parameters of the stimuli in each condition are listed in Table A1 in the Appendix. In total, we used 12 different packages (see Figure 1 for example stimuli).

We conducted a pretest (N = 30) to ascertain that consumers perceive the hydration drinks as less natural than the fruit juices used in Study 1. We measured the perceived naturalness of

Table 5. Descriptive Statistics Study 2: Influence on health and taste expectations of hydration drinks

	M	*SD*
Mean healthiness by color saturation		
Saturation		
Normal saturation	3.81	1.93
Low saturation	3.94	1.78
Mean healthiness by color fit		
Color fit		
Color fit	4.23	1.86
No color fit	3.52	1.78

Fit	Saturation	*M*	*SD*
Mean healthiness by color saturation and fit			
Color fit	Normal saturation	4.31	1.96
Color fit	Low saturation	4.15	1.76
No color fit	Normal saturation	3.31	1.77
No color fit	Low saturation	3.73	1.77

	M	*SD*
Mean tastiness by color saturation		
Saturation		
Normal saturation	4.96	2.18
Low saturation	4.17	1.83
Mean tastiness by color fit		
Fit		
Color fit	4.90	2.10
No color fit	4.23	1.94

Fit	Saturation	*M*	*SD*
Mean tastiness by color saturation and fit			
Color fit	Normal saturation	5.68	2.06
Color fit	Low saturation	4.13	1.83
No color fit	Normal saturation	4.24	2.06
No color fit	Low saturation	4.21	1.82

Source(s): Authors' work

the fruit juices and hydration drinks with three items (Cronbach's α from 0.95 to 0.97), one reverse-coded: 1) "To what extent can you imagine that this drink was made from fresh, natural ingredients?" (1 = *Not at all*; 10 = *Very well*); 2) "To what extent would you say that this drink contains artificial flavors or additives?" (1 = *Not at all*; 10 = *Very strongly*); 3) "How natural do you think this product is?" (1 = *Not natural at all*; 10 = *Very natural*). As expected, participants perceived the hydration drinks as less natural ($M = 2.34$; $SD = 1.18$) than the fruit juices ($M = 6.66$; $SD = 2.15$), $F(1, 89) = 384.03$, $p < 0.001$.

5.1.4 Data analysis. The analysis strategy was identical to the one used in Study 1. Again, we used a linear mixed-effect model analysis (Gałecki and Burzykowski, 2013; Maxwell and Delaney, 2004) to test the influence of color saturation and color fit on consumers' healthiness and tastiness perception.

Source(s): Authors' own work

Figure 1. Experimental stimuli differing in color match and color saturation (Study 2)

All analyses were conducted at a significance level of $\alpha = 0.05$. We used again R 4.3.2 (R Core Team, 2023), the package nlme (Pinheiro *et al.*, 2016) to analyze the data.

5.2 Results

5.2.1 The influence of color saturation, color match, and their interaction on expected healthiness of hydration drinks. A linear mixed effect model was employed to predict healthiness ratings based on color saturation, color match, and their interaction. Random intercepts for both participant and product flavor were incorporated. The objective of this model was to determine if packaging color saturation predicts health ratings and whether this association is influenced by packaging color match. The results of this analysis can be found in Table 6.

Most importantly, the interaction effect between color saturation and color match on healthiness was significant, $F(1, 3{,}579) = 81.11$, $p < 0.001$. We conducted pairwise comparisons of estimated marginal means testing the effect of saturation on health within each color match condition to investigate the moderating influence of color match on the relationship between color saturation and healthiness ratings. In the color match condition, the influence of color saturation on healthiness ratings was significant, $t(3{,}579) = 3.51$, $p < 0.001$. In line with our hypothesis (*H1a*), normally saturated packages were rated as healthier ($M = 4.31$; $SD = 1.96$) than low saturated packages ($M = 4.51$; $SD = 1.76$). Also in the non-color match condition, color saturation had a significant influence on healthiness ratings, $t(3{,}579) = -9.23$, $p < 0.001$. In contrast to the results within the color match condition, normally saturated packages were rated as less healthy ($M = 3.31$; $SD = 1.77$) than low saturated packages ($M = 3.73$; $SD = 1.77$). These findings show that normal color saturation only leads to higher expected health if the packaging color matches the color of the product's main ingredient and confirms the moderating role of a match between the package color and the main ingredient (*H2a*). Additionally, there were significant main effects of color saturation, $F(1, 3{,}579) = 16.39$, $p < 0.001$, and color match, $F(1, 3{,}579) = 487.85$, $p < 0.001$, on healthiness ratings.

Table 6. Results of the LME model testing the effects of color saturation, color match, and their interaction on healthiness ratings of hydration drinks

Predictors	$F(1, 3{,}579)$	p
Intercept	2892.75	<0.001
Color saturation	16.39	<0.001
Color match	487.85	<0.001
Color saturation × color match	81.11	<0.001
Random effects		
σ^2		1.24
$\tau_{00\ \text{product}}$		1.38
$\tau_{00\ \text{id}}$		0.38
N_{product}		3
N_{id}		398
Observations		4,776
Marginal R^2		0.109

Source(s): Authors' work

5.2.2 The influence of color saturation, color match, and their interaction on expected tastiness of hydration drinks. A further linear mixed effect model was conducted to predict the tastiness ratings, taking into account color saturation, color match, and their interaction, with random intercepts for participant and product flavor. This model aimed to ascertain whether packaging color saturation predicts tastiness ratings and whether this relationship is affected by packaging color match. The detailed results are provided in Table 7.

Again, a significant interaction effect between color match and color saturation was demonstrated $F(1, 3{,}579) = 299.71$, $p < 0.001$. Pairwise comparisons of estimated marginal means were run testing the effect of saturation on taste within each color match condition to explore color match's moderating role on the effect of color saturation on tastiness ratings. In the color match condition, color saturation had a significant influence on tastiness ratings, $t(3{,}579) = 24.95$, $p < 0.001$. Normal saturated packages ($M = 5.68$; $SD = 2.06$) were rated as significantly tastier than low saturated packages ($M = 4.13$; $SD = 1.83$). In the non-color match condition, no significant influence of color saturation on tastiness ratings could be observed, $t(3{,}579) = 0.47$, $p = 0.64$. These findings indicate that normal saturated packages are expected to be tastier than low saturated packages, but only when the package color matches the main ingredient. In addition, there were significant main effects of color saturation, $F(1, 3{,}579) = 323.19$, $p < 0.001$, and color match, $F(1, 3{,}579) = 235.77$, $p < 0.001$.

5.3 Discussion

Study 2 extended the findings of Study 1 in an important way: We observed opposite effects of color saturation on expected healthiness depending on the match between primary package color and ingredient. When the primary package color matched the color of the ingredient, we observed the same results as in Study 1. Participants expected the beverages to be healthier when the primary package color was saturated than when it was not. When the package color did not match the ingredient, saturation even led to a lower expectation of healthiness. Thus, Study 2 reflects, at least in part, what has been found in the various studies in the literature: Color saturation can have both positive and negative effects on health expectations. Our results suggest that the saturation-healthiness association depends on the match between the color and main ingredient.

Table 7. Results of the LME model testing the effects of color saturation, color match, and their interaction on tastiness ratings of hydration drinks

Predictors	$F(1, 3{,}579)$	p
Intercept	5460.95	<0.001
Color saturation	323.19	<0.001
Color match	235.77	<0.001
Color saturation × color match	299.71	<0.001
Random effects		
σ^2		2.32
$\tau_{00\ product}$		1.12
$\tau_{00\ id}$		0.46
$N_{product}$		3
N_{id}		398
Observations		4,776
Marginal R^2		0.153

Source(s): Authors' work

An interesting finding of Study 2 is that there were no effects of color saturation on taste expectations in the non-matching color condition. Previous studies have consistently reported positive effects of saturation on taste expectations. For example, Tijssen *et al.* (2017) observed that participants expected yogurt drinks and sausages to be less healthy when high compared to less saturated colors were used, but they found that color saturation increased expected taste intensity. One possible explanation for the difference between the results of Study 2 and previous studies is that we used artificial foods with which participants had no prior experience. Therefore, it is possible that there was no positive taste expectation that could be strengthened or weakened by the saturation.

6. General discussion

Taste and health are critical factors in how consumers evaluate and choose products. It is therefore beneficial for marketers to incorporate visual cues into packaging design that enhance expectations of taste and health. Color saturation is one such cue that can be easily varied in the primary package color.

Some researchers argue that one function of color perception is to help identify foods that are nutritious and healthy (Sánchez-Solano *et al.*, 2020). Congruent to this logic, a basic assumption of the present research was that consumers can learn an association between color and both taste and healthiness when a specific color cue is repeatedly paired with taste and healthiness. In particular, we proposed that color saturation may be an important property of a color that can carry such associations (Palmer and Schloss, 2010). For example, individuals may have repeatedly experienced that a fruit that lost its true color (saturation) tastes bad and can cause illness. We argued that consumers rely on such associations not only when evaluating fresh fruit, but also packaged food.

The results of the two studies support this reasoning, as long as the color of the packages matched the main flavor-giving ingredient. In these conditions, participants expected the presented beverages to be healthier and tastier when the package color had a normal compared with low saturation level. This effect of saturation is congruent to the reasoning that consumers apply a saturation-freshness association to evaluate healthiness and tastiness (Kunz *et al.*, 2020). However, the results also highlight the need to consider limitations of this mechanism.

In Study 2, we found that color saturation had a negative effect on healthiness expectations and no effect on taste expectations when the colors of the packages did not match the contents. Thus, the learned association between saturation and freshness was not applied by participants in this case. Possibly, participants applied another association, such as a saturation-intensity association. Researchers have observed an association between saturation and arousal (Zieliński, 2016). A package with saturated colors might evoke the feeling that the product is more intense or exciting (Gorn *et al.*, 1997). Consumers may rely on this feeling to judge the intensity of the beverage. Because the beverage category used in Study 2 tends to be perceived as unhealthy, consumers might have perceived this unhealthy aspect of the product as stronger or more true (see Mead and Richerson, 2018 for a similar argument). In addition, lower saturation might signal that the unhealthy aspect weighs less and the product appears to be lighter (Mai *et al.*, 2016). Therefore, consumers might have used low saturation as a cue for healthiness in this more processed product category.

Interestingly, we found no effect of color saturation on taste expectations in Study 2 when the color did not match the ingredient. If higher saturation signaled a more intense taste of the beverage, one would have expected that consumers rate a normal vs. low saturated product as tastier, regardless of the match between the package and ingredient color. Potentially, consumers perceived the hydration drinks in Study 2 as artificial. A more intense impression of these artificial drinks might have had no effect on their expected taste, but just made them appear even more artificial. However, this notion remains speculative and has to be tested in future research.

A limitation of this study is that we only examined the effects of saturation and color match for two different product categories. It is possible that consumers have learned to associate different hues and saturation levels with specific product categories, and these learned associations may influence how color saturation and hue influence taste and health expectations. Previous research has shown that the influence of packaging color varies across product categories (Huang and Lu, 2016). It would be valuable to extend the effects of saturation and hue across a variety of product categories. In addition, there may be an optimal level of color saturation for product packaging that is perceived as healthy and tasty. Again, this optimal level may be different for different product categories. Future research could further explore this idea. Extending the effects of saturation and color match to a variety of product categories would be valuable.

Another limitation is that we created artificial product designs and participants were unfamiliar with the products. We would expect weaker effects when consumers are familiar with a product, because then they are likely to have a highly accessible product image that is more important than the perception of the product packaging in the specific situation.

7. Conclusion

The present research contributes to the literature of color effects on product judgments in two ways. First, it provided additional evidence that saturation is an important color cue that signals health and taste. This finding is important given the extensive discussion that health and taste are often perceived as incompatible aspects of food (Haasova and Florack, 2019; Raghunathan *et al.*, 2006). Our findings lend support to the idea that consumers' health and taste judgments of food are often congruent, because they are based partly on the same visual cues. Second, we help explain the incongruent results of previous studies reporting positive (e.g. Kunz *et al.*, 2020) as well as negative (e.g. Tijssen *et al.*, 2017) effects of saturated package colors on expected healthiness. Our results show that the positive association between saturation and healthiness and tastiness most likely occurs when the package color matches the color of the main flavor-giving ingredient, such as orange juice packaged in an orange container. However, product packaging often does not match the colors of the contents, such as milk packaged in blue containers. In these cases, other saturation associations are likely to apply. The formation of these associations may follow similar principles: When taste or health information is paired

with high or low saturation, consumers may learn this association and apply it when encountering new products (Steiner and Florack, 2023).

7.1 Practical implications

Previous research on the interaction between product taste and health perception is ambiguous (Kunz *et al.*, 2020; Mai *et al.*, 2016; Mead and Richerson, 2018; Tijssen *et al.*, 2017). Some studies found a negative correlation between the perceived healthiness of a product and its tastiness (Mai *et al.*, 2016; Mead and Richerson, 2018; Tijssen *et al.*, 2017). This has made it challenging for marketers to successfully design healthy products, as visual cues that signal healthiness may lead to lower tastiness perceptions and therefore lower purchase decisions. Therefore, it is important to identify and utilize visual cues that can simultaneously enhance both healthiness and tastiness perceptions. In line with the study by Kunz *et al.* (2020), our findings demonstrate that color saturation can be such an overlapping cue when there is a color match between the packaging color and the main ingredient of a product. By using a saturated packaging color that matches the main ingredient of a product, a product can be perceived as both tasty and healthy at the same time.

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Appendix

Table A1. Color parameters of the stimuli in the different conditions for Studies 1 and 2

Flavor	Color match	Saturation	Hue name	R	G	B
Orange	Yes	Regular	Orange	235	136	54
	Yes	Low	Orange	215	146	96
	No	Regular	Red	235	21	17
	No	Low	Red	206	78	65
Apple	Yes	Regular	Red	198	11	7
	Yes	Low	Red	174	65	54
	No	Regular	Purple	164	0	159
	No	Low	Purple	147	60	142
Mango	Yes	Regular	Orange	185	81	23
	Yes	Low	Orange	166	95	62
	No	Regular	Pink	176	35	66
	No	Low	Pink	156	65	76

Source(s): Authors' work

Corresponding author
Sonja Kunz can be contacted at: sonja.kunz@univie.ac.at