RESEARCH ARTICLE

Fifty shades of food: The influence of package color saturation on health and taste in consumer judgments

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Abstract

When evaluating food products, consumers rely on visual cues on packages to infer their healthiness and tastiness. We assumed that color, specifically color saturation, is one such cue, similarly relevant for both healthiness and tastiness inferences. We conducted three studies in which we manipulated the color of pictures of product packages. Participants viewed pictures from the category of snacks (Study 1a) and drinks (Studies 1b and 2), available at a supermarket's online store and rated each product on the dimensions of healthiness and tastiness. In two studies, we showed one group of participants product pictures only as grayscale images, whereas another group viewed the pictures in full color. In a third study, we showed participants product pictures once with increased and once with decreased color saturation. We consistently found a positive correlation between healthiness and tastiness. Presenting pictures of products as grayscale images weakened the healthy-tasty correlation. Products with increased compared with decreased color saturation were rated as both healthier and tastier, mediated by the products' perceived freshness.

KEYWORDS
color saturation, food products, freshness, healthiness, product package, tastiness, visual cues

1 | INTRODUCTION

Whether a food product is healthy and whether it tastes good are among the most important criteria for consumers when deciding about what to eat (Johansen, Næs, & Hersleth, 2011; Mai, Zahn, Hoppert, Hoffmann, & Rohm, 2014; Steptoe, Pollard, & Wardle, 2013). Therefore, it is desirable for marketers to depict products as healthy and tasty at the same time. To date, the relationship between perceived healthiness and tastiness in consumer judgments of products is controversial. On the one hand, research findings indicated that consumers follow an unhealthy = tasty intuition, that is, they believe unhealthy food to taste better than healthy food (Liem, Toraman Aydin, & Zandstra, 2012; Raghunathan, Naylor, & Hoyer, 2006). In contrast, more recent findings indicated an opposing healthy = tasty view in consumers (Haasova & Florack, 2019a, 2019b;

Landry et al., 2018; Luomala et al., 2015; Werle, Trendel, & Ardito, 2013). We believe that the healthy = tasty view is predominant in consumers because we think that the same cues on product packages can indicate health and taste to consumers. When evaluating products, consumers rely on visual package cues to infer their attributes (Deliza, 1996; Orquin, 2014). One cue that could be used in marketing to promote a product's healthiness and tastiness is package color. However, previous research only focused on color as cue for either healthiness (Karnal, Machiels, Orth, & Mai, 2016; Lu & Huang, 2013; Mead & Richerson, 2018; Schuldt, 2013) or tastiness of food products (Becker, van Rompay, Schifferstein, & Galetzka, 2011; Machiels & Karnal, 2016). At best, some studies proposed that the same color cues that communicate superior health, at the same time indicate inferior taste to consumers and vice versa (Huang & Lu, 2015; Mai, Symmank, & Seeberg-Elverfeldt, 2016). Yet, we believe

that color contributes to both a product's perceived healthiness and tastiness in a similar way. Concretely, we propose that vivid, saturated colors on product packages indicate healthiness and tastiness to consumers.

In three studies, we investigated two main research questions: First, how does the presence (vs. absence) of colors on product packages influence the relationship between healthiness and tastiness judgments of food products? Second, how does a specific aspect of package color, namely saturation, influence both health and taste judgments?

In the first two studies of the present research, we manipulated the availability of color as a relevant package cue and tested its influence on the relationship between participants' healthiness and tastiness judgments. We assume that color is one of the overlapping package cues informing both consumers' healthiness and tastiness inferences, thereby contributing to the positive healthiness–tastiness relationship. Therefore, we expected this relationship to be reduced when color as a cue was not available.

In a third study, we manipulated saturation as one specific aspect of package color and tested its effect on perceived healthiness and tastiness of products. Past research found that products in vivid, color-saturated compared with muted, less color-saturated packages are expected to taste better (Tijssen, Zandstra, de Graaf, & Jager, 2017), but also to be less healthy (Mead & Richerson, 2018; Tijssen et al., 2017). Further, juices with more saturated compared with less saturated colors have been found to appear tastier (Wei, Ou, Luo, & Hutchings, 2012) and fresher (Wei et al., 2012; Wei, Ou, Luo, & Hutchings, 2014). We assume that consumers expect a fresh-looking product to be both healthier and tastier than a stale, no longer fresh product. We propose that more color-saturated compared with less color-saturated packages are judged as fresher and therefore both healthier and tastier.

1.1 | Conceptual background and hypotheses

Past studies proposed that consumers often apply an unhealthy = tasty heuristic in food perception (Liem et al., 2012; Raghunathan et al., 2006), meaning that they tend to think that unhealthy food tastes better than healthy food and vice versa. In contrast, more recent work (Haasova & Florack, 2019a, 2019b; Landry et al., 2018; Luomala et al., 2015; Werle et al., 2013) showed that people rather see healthy food as tastier in comparison to unhealthy food and vice versa. One possible explanation for this association between healthiness and tastiness is that consumers use partly the same product cues to assess its healthiness and tastiness. If people look at a novel food product, they cannot perceive its true healthiness and tastiness but have to draw inferences about these attributes, based on visual cues (Orquin, 2014). We assume that an evolutionary mechanism allows people to infer a food's healthiness and tastiness based on the same visual cues. For example, a fresh and ripe apple would probably be considered both healthy and tasty whereas an old and rotten apple would neither be expected to taste good nor to be

healthful. In this example, the apple's healthiness and tastiness judgments are derived from overlapping cues for both attributes, such as freshness and ripeness, and are thus positively associated. A positive association between a food's nutritional value and tastiness yielded a selective advantage, as it allowed our ancestors to approach food essential for survival while avoiding poisonous foods due to their foul taste (Birch, 1999).

Packaged products as well as entail visual cues indicating both healthiness and tastiness. For example, cues related to naturalness have been found to signal good taste as well as superior healthiness to consumers (Lunardo & Saintives, 2013; Prada, Garrido, & Rodrigues, 2017). Another visual cue indicating both a product's healthiness and tastiness is the attractiveness of the package design. Studies have shown that an attractive package design affects both taste expectations (Becker et al., 2011; Mizutani et al., 2010; Velasco, Salgado-Montejo, Marmolejo-Ramos, & Spence, 2014) and healthiness perceptions (Karnal et al., 2016; Visschers, Hess, & Siegrist, 2010). Moreover, attractiveness is the most important factor determining product choice and correlates positively with both a product's healthiness as well as tastiness (van der Laan, de Ridder, Viergever, & Smeets, 2012). Taken together, we have reason to believe that the same visual cues on product packages help to assess a food's healthiness as well as tastiness, thus contributing to the positive healthiness–tastiness relationship. Based on these arguments as well as on previous findings (Haasova & Florack, 2019a; Luomala et al., 2015; Werle et al., 2013), we hypothesized:

H1: *The relationship between judgments of healthiness and tastiness of food products will be positive.*

As pointed out in the introduction, we suppose that one visual aspect of food products that are used in differentiating tasty from not tasty and healthy from not healthy food is color. Referring to the example of the apples above, color vision helps people find fresh apples among the spoiled ones and fallen leaves. It is the apple's color that tells us at first glance whether it is ripe (Richardson-Harman, Phelps, McDermott, & Gunson, 1998) and fresh and therefore healthy and tasty, or, whether it is not yet ripe or already rotten and therefore neither tasty nor healthy. Indeed, researchers have speculated that one function of color vision is to find and identify edible food (Osorio & Vorobyev, 1996; Regan et al., 2001). Also, modern food science and research in psychology stress the important role of color in food perception (Spence, 2015). There is a plethora of research demonstrating that people tend to match certain colors with the basic tastes (i.e., sweet, sour, salty, bitter, umami; see Spence et al., 2015 for a review) and that color helps people to correctly identify a food or drink's flavor (e.g., Garber, Hyatt, & Starr, 2000; Zampini, Sanabria, Phillips, & Spence, 2007). On the other hand, colors on food product packaging also influence healthiness judgments (Karnal et al., 2016; Lu & Huang, 2013; Mead & Richerson, 2018; Schuldt, 2013). Schuldt (2013), for instance, provides evidence that products are perceived to be healthier when calorie labels are displayed in green rather than red or white.

Taken together, the color of food products as well as on product packages is a highly relevant visual cue, used by people to make inferences about both health and taste attributes of food. However, whereas previous research only focused on color as cue for either healthiness (Karnal et al., 2016; Lu & Huang, 2013; Mead & Richerson, 2018; Schuldt, 2013) or tastiness of food products (Becker et al., 2011; Machiels & Karnal, 2016), evidence for the influence of color on both healthiness and tastiness of food and the relationship between them is lacking.

We presume that colors on product packages convey meaning to consumers and produce an immediate impression, informing spontaneous judgments of both healthiness and tastiness judgments. Research shows that peoples' first visual impression of a product package may determine their product choice and that color is one of the main aspects affecting this impression (Garber, Burke, & Jones, 2000). Colors have the potential to immediately evoke certain emotions and activate semantic concepts (Clarke & Costall, 2008; Kaya & Epps, 2004). For example, the colors green and blue are associated with calming, relaxing, and positive emotions. The green color is associated especially with nature (Clarke & Costall, 2008; Kaya & Epps, 2004).

By contrast, people regard gray color as neutral, un-emotive and even termed it the "no-man's land" of colors (Clarke & Costall, 2008). Further, black and white, as opposed to color imagery, has been found to increase psychological distance towards objects (Lee, Deng, Unnava, & Fujita, 2014). After this, products in colorless packaging may seem more distant and less "real" to consumers and might be perceived and evaluated differently than products in colorful packages.

Importantly, we do not imply that the mere presence of color automatically increases a food product's perceived healthiness and tastiness. Rather, the presence of the color cue makes it easier for consumers to differentiate between products (Garber et al., 2000) and identify the ones that appear tasty and healthy as well as the ones that do not. This means that the presence of colors could as well lead to decreased healthiness and tastiness judgments. Because color helps people to assess the healthiness and tastiness of food products and distinguish between products in this way, the color should also contribute to the relationship between perceptions of healthiness and tastiness. Reducing the variety of colors should lead to a weaker relationship between perceived healthiness and tastiness because one of the cues that is relevant for the formation of both judgments will be absent. Presenting pictures of products to consumers only as grayscale images (reducing the color information of each pixel to brightness information) should render the formation of healthiness and tastiness judgments more difficult and reduce the congruence between the two judgments. Hence, we hypothesized:

H2: *The healthiness–tastiness relationship will be weaker in magnitude, but will remain positive when pictures of food products are reduced to grayscale images compared with when they are in full-color format.*

Specific dimensions of the product and package colors, such as brightness and saturation affect consumer judgments of healthiness

and tastiness as well. For example, juices with deeper, more saturated colors, have been found to appear tastier (Hoegg & Alba, 2007; Wei et al., 2012) and fresher (Wei et al., 2012, 2014). Products in vivid, color-saturated packages are expected to taste better than pale and less color-saturated packages (Tijssen et al., 2017), but also to be less healthy (Mead & Richerson, 2018; Tijssen et al., 2017). However, we propose that color saturation can indicate both tastiness and healthiness to consumers. Given that highly saturated colors increase perceptions of freshness (Wei et al., 2012, 2014) and assuming that consumers probably expect a fresh product to be tastier as well as healthier than an old product, we expect products in color-saturated packages to be judged as both healthier and tastier than products in muted, less color-saturated packages. We, therefore, hypothesized:

H3: *Products will be evaluated as less healthy, less tasty and less fresh when the color saturation of pictures of product packages is reduced.*

As we assume that color saturation has a positive effect on healthiness and tastiness because it increases perceptions of freshness, we further hypothesized:

H4: *The effect of saturation on healthiness and tastiness will be mediated by perceived freshness.*

1.2 | The present research

This paper has three main objectives. First, we replicated previous research findings (Haasova & Florack, 2019a), showing a positive relationship between consumers' evaluation of healthiness and tastiness of food products. Second, as we argue that this relationship is formed by overlapping cues for healthiness and tastiness, we tested how removing a relevant cue, that is, color affects this relationship. Third, we tested how manipulation of one specific dimension of color, namely saturation, simultaneously affects healthiness and tastiness perceptions, thus demonstrating how the same color cue can influence both health and taste perceptions in a similar way. We conducted three studies with the basic methodology adapted from Haasova and Florack (2019a). Study 1a investigated the effect of color on the correlation between participants' healthiness and tastiness judgments of snack products, shedding light on the mechanism behind the positive healthiness–tastiness relationship. Study 1b replicated the procedure with another product category (drinks) and controlled for the products' perceived attractiveness on the healthiness and tastiness of the food. In Study 2, we investigated the effect of reduced versus increased package color saturation on healthiness and tastiness and its mediation by perceived freshness.

We used a representative sample of real food products sold in the online store of two well-established supermarket chains. In Study 1a, all stimulus products were from the category of snacks (e.g., chips, nuts, and dried fruits) whereas in Study 1b and 2, we used products from the category of nonalcoholic drinks (e.g., juices, sodas, and

smoothies). Thereby, we increased the ecological validity and generalizability of our research. Additionally, all studies included measures of individual differences between participants (belief in the unhealthy = tasty intuition, general health interest, and food pleasure orientation), to control for their possible influence on the healthiness–tastiness relationship. Past research found that the healthiness–tastiness correlation varies between consumers, due to individual differences on these constructs (Haasova & Florack, 2019a; Huang & Wu, 2016; Werle et al., 2013).

Moreover, in two studies, we addressed the problem of common method variance (Lindell & Whitney, 2001; Podsakoff, MacKenzie, Lee, & Podsakoff, 2003), potentially stemming from the applied methodology (Study 1a, b) and participants' social desirability (Study 1b).

2 | STUDY 1a: THE INFLUENCE OF PACKAGE COLOR ON THE RELATIONSHIP BETWEEN HEALTHINESS AND TASTINESS JUDGMENTS

2.1 | Methods

2.1.1 | Participants

A representative sample of individuals recruited through an access panel ("Talk Online Panel") participated in the online study in exchange for 250 €. 245 consumers from Austria took part in the survey, with nine subsequently excluded because they did not complete the questionnaire. The final sample then consisted of 236 participants ($N_{condition\ in\ color}$ = 120, $N_{condition\ no\ color}$ = 116), 51.7% female, with a mean age of 42.59 years (standard deviation [SD] = 14.30) and a mean body mass index (BMI) of 25.39 (SD = 5.32). 10.6% of participants reported having completed a vocational school or training institute, while 40.3% had finished high school and 38.1% were university educated.

2.1.2 | Design, procedure, and materials

This study employed a two (package color: Full color vs. grayscale) between-subject design. In the first condition, we presented participants with pictures of food product packages in their original full coloring, following Haasova and Florack (2019a). In the second condition, we removed the color cue by presenting the pictures of the packages in a grayscale format, without colors, while making no changes to brightness or saturation of the pictures.

Participants viewed pictures of 20 products from the snack category (e.g., chips, nuts, and dried fruits), randomly sampled per participant from a pool of 167 snack products offered by the online store of a large local supermarket chain at the time of the study, meaning that participants knew the products. They viewed and immediately rated each product picture separately before moving to the next picture. Depending on the

condition, the pictures were in their original full coloring or in a grayscale format. Participants judged each product's perceived healthiness and tastiness in two separate rating blocks, so each product picture was presented twice. The order of the products was kept constant, yet the order of the evaluation category (i.e., healthiness or tastiness) was random. That is, some participants first evaluated a product's healthiness, followed by tastiness and others first evaluated tastiness, followed by healthiness. Participants indicated how healthy and how tasty they perceived each product to be, using scales ranging from 1 (very unhealthy/not at all tasty) to 10 (very healthy/very tasty).

Afterward, participants answered questions regarding demographic variables (e.g., age and gender). We also measured the explicitness of participants' belief in the unhealthy = tasty intuition (Raghunathan et al., 2006) by asking participants' agreement on a 9-point-scale (1 = strongly disagree, 9 = strongly agree) with the following two items: (a) "Things that are good for me rarely taste good", and (b) "There is no way to make food healthier without sacrificing taste." Also, participants' general health interest (Roininen, Lähteenmäki, & Tuorila, 1999) was assessed with eight items (e.g., "I am very particular about the healthiness of food I eat") to which participants indicated their agreement on a 7-point-scale (1 = strongly disagree, 7 = strongly agree). Eventually, we measured participants' food pleasure orientation (Rozin, Fischler, Imada, Sarubin, & Wrzesniewski, 1999) by asking for their agreement on a 7-point-scale (1 = strongly disagree, 7 = strongly agree) with six items (e.g., "Enjoying food is one of the most important pleasures in my life"). Participants' answers to all items of each scale were averaged to create an overall score for each respective variable. For descriptive statistics of these variables and the scales' Cronbach's α values, see Table 1.

We additionally assessed a marker variable to control for the possible effects of common method variance (Lindell & Whitney, 2001). Such unwanted effects can stem from sources like "common rater effect" or "common scale formats" (Podsakoff et al., 2003). We used the following question as our marker variable: "How often do you use social media (Facebook, Twitter, Pinterest …)?" on a scale ranging from 1 (not at all) to 10 (very often).

2.1.3 | Data analysis

Participants' evaluations are nested within participants and inter-correlated, owing to the fact that they repeatedly evaluated multiple food products, varying in healthiness and tastiness. To test our hypotheses, we used repeated measures correlation analysis and linear mixed-effect model analysis (Gałecki & Burzykowski, 2013;

TABLE 1 Descriptive statistics and Cronbach's α coefficients for the scales in Study 1a

Variable	M (SD)	α
Belief in unhealthy = tasty intuition	3.55 (2.00)	.80
General health interest	4.42 (1.14)	.83
Food pleasure orientation	5.27 (1.00)	.74

Abbreviations: *M*, mean; *SD*, standard deviation.

Maxwell & Delaney, 2004), to account for this issue. We conducted all analyses with SPSS and R (R Core Team, 2016) statistics software, specifically the packages rmcorr (Bakdash & Marusich, 2017), lme4 (Bates, Maechler, Bolker, & Walker, 2015), and nlme (Pinheiro, Bates, DebRoy, Sarkar, & R Core Team, 2016). The significance level was $\alpha = 0.05$ for all analyses. Our main focus was the relationship between healthiness and tastiness evaluations across participants and its dependence on our experimental manipulation of package coloring (full color vs. grayscale format).

2.2 | Results

2.2.1 | Correlations between healthiness and tastiness

To test the basic assumption that healthiness is positively correlated with tastiness, we conducted repeated-measures correlations between the respective variables, using the rmcorr R package (Bakdash & Marusich, 2017). Repeated measures correlation allows to estimate the correlation coefficient between two measures, assessed on multiple occasions, while taking the dependence of observations into account. The correlation coefficient is estimated using an analysis of covariance model, in which the participant is the factor variable, while the two measures to be correlated, are the outcome variable and the covariate. Results revealed a significant positive correlation between healthiness and tastiness, $r(4483) = .31$, $p < .001$.

2.2.2 | Influence of color on the healthiness–tastiness relationship

To test our hypothesis that the positive healthiness–tastiness relationship would be weaker in magnitude when pictures of products were presented in grayscale format rather than full color, we applied a linear mixed-effect model analysis. The basic model involved healthiness, package color, and their interaction as independent variables, while tastiness was the dependent variable. The model included a random intercept, while healthiness, and package color was treated as fixed factors. All continuous variables were centered on their grand means.

Replicating findings from previous work (Haasova & Florack, 2019a), the analysis revealed a positive association between the healthiness and tastiness attribute evaluations as indicated by the main effect of healthiness on tastiness (see Table 2). The main effect of package color on healthiness was not significant ($p = .114$), indicating that healthiness judgments did not differ between the color and the grayscale condition. Importantly, a significant interaction between healthiness and package color, $b = 0.04$ (standard error [SE] = 0.01), $t(4482) = 2.35$, $p = .019$, suggested that the healthiness–tastiness relationship was still positive and significant, but less robust in the grayscale condition, $b = 0.31$ ($SE = 0.02$), $t(2203) = 14.34$, $p < .001$, in comparison to the full-color condition, $b = 0.38$ ($SE = 0.02$),

TABLE 2 Parameter estimates of the effect of healthiness and package color on tastiness, using linear mixed-effect model (LMM) analysis in Study 1a

Parameter	
Fixed effects	
Intercept	5.83* (.08)
Healthiness	.34* (.01)
Package color	.13 (.08)
Healthiness X package color	.04** (.01)

Note: Values are parameter estimates predicting the tastiness ratings of products. Standard errors appear in parentheses. The continuous variable in the model, healthiness, is centered on its grand mean and package color is a dichotomous variable coded as follows: −1 = "grayscale," 1 = "full color".
*$p < .001$
**$p < .05$

$t(2279) = 17.90$, $p < .001$. The reported linear mixed-effect model explains about 35% of the variance in the data (conditional $R^2 = 0.35$). The results remained stable after controlling for the individual characteristics (belief in the unhealthy = tasty intuition, general health interest, and food pleasure orientation) in the basic model.

2.2.3 | Correcting for common scale formats as a presumed source of common method variance (CMV)

We addressed the possible influence of common method variance on our results through the following statistical controls. We employed a marker variable, as proposed by Lindell and Whitney (2001), that was theoretically irrelevant and unrelated to the analyzed constructs. When including the marker variable in our linear mixed-effect model, we did not observe any changes in the significance levels nor the valences of the estimates. This suggests that common method variance was not a problem in the analysis.

Furthermore, we conducted Harman's single factors test where we included all items measuring different constructs (healthiness, tastiness, belief in the unhealthy = tasty intuition, general health interest, and food pleasure orientation) in our study in exploratory factor analysis. The exploratory factor analysis showed that the total variance for a single factor solution to our data (single factor in extraction) was far less than 50% (with 14.63% being the most variance explained by any one factor), thus providing no evidence for common method variance.

2.3 | Discussion

In Study 1a, we found an overall positive association between participants' healthiness and tastiness judgments of food products.

Moreover, the correlation was still positive, but weaker for participants, who saw the pictures of products in a grayscale format in comparison to full coloring. This supports our argument that color is one of the cues used to infer both healthiness and tastiness in a similar fashion and thus influences the relationship between those two attributes. Presence of color did not affect the products' healthiness and tastiness, but the relationship between them. It is possible that removing the colors reduced the differences in attractiveness between products. As attractiveness is important for product evaluations (Becker et al., 2011; Karnal et al., 2016; Mizutani et al., 2010; van der Laan et al., 2012; Velasco et al., 2014; Visschers et al., 2010), this might have rendered judgments of health and tasteless congruent. Study 1b aimed to strengthen the findings of Study 1a, by replicating the procedure with another product category (i.e., nonalcoholic drinks) while controlling for the influence of product packages' attractiveness.

3 | STUDY 1b: CONTROLLING FOR ATTRACTIVENESS

3.1 | Methods

3.1.1 | Participants

A sample of 116 students ($N_{\text{condition in color}}$ = 58, $N_{\text{condition no color}}$ = 58) from the University of Vienna, 75.9% female, with a mean age of 22.17 years (SD = 2.44) and a mean BMI of 21.22 (SD = 2.78) participated in the study in exchange for course credit. 86.2% of participants had finished high school and 12.9% had a university or college degree.

3.1.2 | Design, procedure, and materials

The design and procedure of Study 1b were basically identical to that in Study 1a, with a few changes: In Study 1b, we presented participants with 20 pictures of products from the nonalcoholic drinks category (e.g., juices, sodas, and smoothies) rather than the snack category. The products were randomly sampled from a pool of 262 drink products, offered at the online store of the same supermarket as in Study 1a.

Participants rated each products' healthiness and tastiness in two separate blocks. Addressing the "common scale format" and following Podsakoff's et al. (2003) recommendations for procedural remedies, we applied a methodological separation of the healthiness and tastiness measurements by employing two different scale formats to measure the two constructs. The scale for measuring the tastiness judgments remained the same: "How tasty do you estimate the presented product to be?" with response options ranging from 1 (not at all tasty) to 10 (very tasty) in a horizontal Likert format. But the healthiness judgments were assessed with a staple scale format: "How healthy do you estimate the presented product to be?" with

response options ranging from +5 to +1 (indicating healthiness) and −1 to −5 (indicating unhealthiness), displayed vertically underneath each other without option labels. Participants were told, "+5 indicates a very high estimate of a product's healthiness," and "−5 indicates a very low estimate of a product's healthiness." For the sake of simplicity in the statistical analyses, the healthiness scores were subsequently recoded to reflect the same scale as the tastiness scores (1 = very unhealthy and 10 = very healthy). We again randomized the order in which the healthiness and tastiness assessments were presented (resulting in two order types: Healthiness or tastiness judgments first) to avoid memory and reference-point effects. This time, we also randomized the order of the presented products in each assessment to decrease potential biases in the effects of memory on product evaluations. After having rated all product pictures on both dimensions, participants rated each product's attractiveness. They indicated how beautiful they found each product's overall package design by selecting a number of stars icons from 1 (not at all beautiful) to 7 (very beautiful).

In Study 1b, we applied a statistical correction for social desirability as another potential source of CMV during the analyses. Social desirability is the tendency to present oneself favorably, regardless of the person's true position on the construct being measured (Crowne & Marlowe, 1964). We measured the individual tendency for social desirability with the Soziale-Erwünschtheits-Skala-17 (Stöber, 1999), consisting of 17 items (example item: "I accept all other opinions, even when they do not correspond to my own"), seven reverse-coded, with response options 1 (correct) and 0 (incorrect). The general level of social desirability was computed by summing the responses across the 17 items.

Like in Study 1a, we also measured participants' explicitness of belief in the unhealthy = tasty intuition (Raghunathan et al., 2006), general health interest (Roininen et al., 1999), and food pleasure orientation (Rozin et al., 1999). For descriptive statistics of these variables and the scales' Cronbach's α values, see Table 3.

3.1.3 | Data analysis

The analysis strategy was similar to the one used in Study 1a. We tested basic correlations between healthiness, tastiness, and attractiveness, using repeated measures correlations (Bakdash & Marusich, 2017), taking the dependence of measurement points within participants into account. To test the influence of color on the healthiness–tastiness relationship, we used linear mixed-effect model analysis (Gałecki & Burzykowski, 2013; Maxwell & Delaney, 2004).

TABLE 3 Descriptive statistics and Cronbach's α coefficients for the scales in Study 1b

Variable	M (SD)	α
Belief in unhealthy = tasty intuition	2.15 (1.52)	.71
General health interest	4.52 (1.15)	.84
Food pleasure orientation	5.50 (1.06)	.74

Abbreviations: M, mean; SD, standard deviation.

We conducted all analyses with SPSS and R (R Core Team, 2016) statistics software, specifically the packages rmcorr (Bakdash & Marusich, 2017), lme4 (Bates et al., 2015) and nlme (Pinheiro, Bates, DebRoy, Sarkar, & Core Team, 2016). The significance level was $\alpha = 0.05$ for all analyses. Our main focus was the relationship between healthiness and tastiness evaluations across participants and its dependence on our experimental manipulation of package coloring (full color vs. grayscale format). Additionally, we analyzed the influence of attractiveness on healthiness, tastiness, and their relationship, depending on the package color condition.

We applied a statistical correction for social desirability, the second potential source of CMV. Siemsen, Roth and Oliveira (2010) and Simmering, Fuller, Richardson, Ocal, and Atinc (2015) suggested to include presumed CMV source variables in the regression equation to correct for their potential biasing effects. Whereas this procedure might produce a decrease in the estimates of the regression slopes, if the effects of the CMV source variables are not substantial, the equation should yield comparatively unbiased estimates of the assessed substantive relationships. Thus, to correct for any biases due to social desirability in our data, we included the social desirability variable in our basic statistical model and compared and estimated its effects and the two models separately. In addition, considering that the causes of CMV might not only suppress true or expose spurious relationships but also moderate the substantive independent–dependent variable relationship (Ganster, Hennessey, & Luthans, 1983), we also assessed social desirability as a moderator of the relationship between healthiness and tastiness judgments.

3.2 | Results

3.2.1 | Correlations between healthiness, tastiness, and attractiveness

To test the basic assumption that healthiness is positively correlated with tastiness, and to test whether attractiveness is positively correlated with healthiness as well as tastiness, we conducted repeated-measures correlations between the respective variables. Results revealed significant positive correlations between healthiness and tastiness, $r(2203) = .42$, $p < .001$, as well as between attractiveness and tastiness, $r(2203) = .48$, $p < .001$, and attractiveness and healthiness, $r(2203) = .37$, $p < .001$.

3.2.2 | Influence of color on the healthiness–tastiness relationship

To test our hypothesis that the positive healthiness–tastiness relationship would be weaker in magnitude when pictures of products were presented in grayscale format rather than full color, we applied the same linear mixed-effect model analysis as in Study 1. Healthiness, package color, and their interaction were the independent variables, while tastiness was the dependent variable. The

model included a random intercept, while healthiness and package color were treated as fixed factors. All continuous variables were centered on their grand means.

Like in Study 1a, we found a positive association between the healthiness and tastiness ratings as indicated by the main effect of healthiness on tastiness (see Table 4). There was no main effect of package color on healthiness ($p = .711$), that is healthiness perceptions of products did not differ between the color and the grayscale condition. In line with our hypothesis, there was a significant interaction between healthiness and package color, $b = 0.06$ ($SE = 0.02$), $t(2202) = 3.05$, $p = .002$, suggesting that the healthiness–tastiness relationship was still positive and significant, but weaker in the grayscale condition, $b = .37$ ($SE = 0.03$), $t(1101) = 13.72$, $p < .001$, in comparison to the full-color condition, $b = 0.49$ ($SE = 0.03$), $t(1101) = 17.91$, $p < .001$. The reported linear mixed-effect model explains 32% of the variance in the data (conditional $R^2 = 0.32$). The results remained stable after controlling for individual characteristics (belief in the unhealthy = tasty intuition, general health interest, and food pleasure orientation) in the basic model.

3.2.3 | Controlling for attractiveness

To test whether package color still influences the healthiness–tastiness relationship when attractiveness is controlled for, we conducted another linear mixed-effect model. We predicted tastiness based on healthiness, package color, attractiveness and the two-way interactions between healthiness and package color as well as between attractiveness and package color. The effects of attractiveness and its significant two-way interaction with package color were significant (see Table 5). There was a positive correlation between attractiveness and tastiness, $b = 0.54$ ($SE = 0.03$), $t(2200) = 19.79$,

TABLE 4 Parameter estimates of the effect of healthiness and package color on tastiness, using linear mixed-effect model (LMM) analysis in Study 1b

Parameter	
Fixed effects	
Intercept	5.64*
	(.11)
Healthiness	.43*
	(.02)
Package color	−.04
	(.11)
Healthiness X package color	.06**
	(.02)

Note: Values are parameter estimates predicting the tastiness ratings of products. Standard errors appear in parentheses. The continuous variable in the model, healthiness, is centered on its grand mean and package color is a dichotomous variable coded as follows: −1 = "grayscale," 1 = "full color".
*$p < .001$
**$p < .01$

TABLE 5 Parameter estimates of the effect of healthiness, attractiveness, and package color on tastiness, using linear mixed-effect model (LMM) analysis in Study 1b

Parameter	
Fixed effects	
Intercept	5.64* (.10)
Healthiness	.29* (.02)
Package color	−.03 (.10)
Attractiveness	.54* (.03)
Healthiness X package color	.03 (.02)
Attractiveness X package color	.05** (.03)

Note: Values are parameter estimates predicting the tastiness ratings of products. Standard errors appear in parentheses. The continuous variables in the model, healthiness, and attractiveness are centered on their grand means and package color is a dichotomous variable coded as follows: −1 = "grayscale," 1 = "full color".
*$p < .001$
**$p < .05$

$p < .001$, which was weaker in the grayscale condition, $b = .49$ ($SE = 0.04$), $t(1100) = 12.35$, $p < .001$, compared with the full-color condition, $b = 0.32$ ($SE = 0.03$), $t(1100) = 15.80$, $p < .001$.

Importantly, the interaction between healthiness and package color, $b = 0.06$ ($SE = 0.02$), $t(2202) = 3.05$, $p = .002$, was no longer significant ($p = .11$) after including attractiveness in the model. The main effect of healthiness on tastiness still remained significant, $b = 0.29$ ($SE = 0.02$), $t(2200) = 15.07$, $p < .001$. All effects also remained stable after we controlled for the additional variables (belief in the unhealthy–tasty intuition, general interest in health, food pleasure orientation) in the model.

3.2.4 | Correcting for social desirability as a presumed CMV source

The results of the basic model including social desirability did not reveal any significant effect of social desirability on the tastiness ratings. Also, the significance levels and the valences of the estimates representing the healthiness–tastiness relationship did not change after we included the social desirability variable (see Table 6). A systematic comparison of the basic model and the model that included social desirability showed that the two models were not significantly different from one another ($p = .22$). The observed relationships did not change on a practical level after we corrected for the variance associated with social desirability, a potential source of CMV. All effects also remained stable after controlling for the additional variables (belief in the unhealthy–tasty intuition, general interest in health, food pleasure orientation) in the model.

TABLE 6 Parameter estimates of the effect of healthiness and package color on tastiness, using linear mixed-effect model (LMM) analysis in Study 1b

Parameter	
Fixed effects	
Intercept	5.64* (.11)
Healthiness	.43* (.02)
Package color	−.04 (.11)
Healthiness X package color	.06** (.02)
Social desirability	−.05 (.04)

Note: Values are parameter estimates predicting the tastiness ratings of products. Standard errors appear in parentheses. The continuous variables in the model, healthiness and social desirability, are centered on their grand means and package color is a dichotomous variable coded as follows: −1 = "grayscale," 1 = "full color".
*$p < .001$
**$p < .01$

Additionally, we estimated the influence of individuals' social desirability on the correlation between healthiness and tastiness judgments by means of a moderation analysis, including the healthiness and social desirability interaction and the three-way interaction of healthiness, package color, and social desirability. There were no significant interactions between social desirability and any of the other variables, indicating that social desirability did not influence the healthiness–tastiness correlation in our sample.

3.3 | Discussion

In Study 1b, we again found an overall positive correlation between participants' healthiness and tastiness judgments of drink products, which was weaker for participants who saw the product pictures in grayscale format, rather than in full coloring. This yields further support for the assumption that color is one of the cues influencing the healthiness–tastiness association.

Importantly, there was no longer a significant difference in the strength of the healthiness–tastiness correlation between package color conditions after we included the products' attractiveness in the model. This indicates that colors affect the healthiness–tastiness relationship to some extent by helping to differentiate between attractiveness of products which is itself positively related to both healthiness and tastiness.

The first two studies showed that colors have an impact on the healthiness–tastiness relationship in product evaluations, but they did not show which particular color cues can simultaneously increase or decrease a product's perceived healthiness and tastiness. We assume that color-saturation is a specific color cue indicating freshness to consumers and that fresh products are thought to be both healthier and

tastier. In Study 3, we manipulated saturation as one particular aspect of package color and tested its influence on both healthiness and tastiness judgments via its effect on freshness perceptions.

4 | STUDY 2: THE INFLUENCE OF PACKAGE COLOR SATURATION ON HEALTHINESS AND TASTINESS JUDGMENTS

4.1 | Methods

4.1.1 | Participants

A representative sample of Austrian consumers recruited through an access panel ("Talk Online Panel") participated in the online study in exchange for 250 €. The sample consisted of 171 participants, 50.9% female, with a mean age of 47.22 years (SD = 15.90) and a mean BMI of 26.01 (SD = 4.80). 50.3% of participants reported having completed a vocational school or training institute, while 19.3% had finished high school, 17% had finished compulsory school, and 8.2% were university educated.

4.1.2 | Design, procedure, and materials

Study 2 implemented a two (Package color saturation: High vs. low) within-subject design with a procedure similar to Studies 1a and 1b. We collected 20 product pictures from the nonalcoholic drinks category (e.g., juices and smoothies) offered at the online store of a foreign supermarket, that is, participants did not know the products. Of these 20 products, 13 were packaged in transparent bottles, meaning that the actual product was visible to participants. The remaining seven products were packaged in opaque cartons such that the actual product was not visible. For each product picture, we created a high saturation-version, increasing the picture's color saturation of 25% and a low saturation-version with a decrease of 25% in color saturation, while keeping all other color dimensions constant.

Participants viewed both the high saturation and the low saturation pictures of the same products, that is, they viewed altogether 40 product pictures. They were explicitly informed in the instructions that they would see the same product twice in slightly different packaging and that the study aimed at exploring the effects of these differences on product perceptions. Participants rated each products' healthiness and tastiness in two separate blocks, meaning that they viewed each product four times, twice with decreased and twice with increased color saturation. We used the same scales as in Study 1b for the healthiness and tastiness ratings but extended the scales to 11 points to allow for a neutral answer. The order of the healthiness and tastiness assessments, as well as the order of the presented products in each assessment, were again random. After having rated all product pictures on both dimensions, participants rated each product's freshness on a horizontal slider scale, ranging from 1 (not at all fresh) to 11 (very fresh).

TABLE 7 Descriptive statistics and Cronbach's alpha coefficients for the scales in Study 2

Variable	M (SD)	α
Belief in unhealthy = tasty intuition	3.93 (2.19)	.73
General health interest	4.48 (1.14)	.81
Food pleasure orientation	5.14 (1.10)	.75

Abbreviations: M, mean; SD, standard deviation.

Like in Studies 1a and 1b, we also measured participants' explicitness of belief in the unhealthy = tasty intuition (Raghunathan et al., 2006), general health interest (Roininen et al., 1999), and food pleasure orientation (Rozin et al., 1999). For descriptive statistics of these variables and the scales' Cronbach's α values, see Table 7.

4.1.3 | Data analysis

In Study 2, all participants evaluated the same 20 product pictures, once with increased and once with decreased color saturation. To test our hypotheses, we used a paired-samples t test and mediation for repeated measures. We conducted all analyses with SPSS and R (R Core Team, 2016) statistics software, specifically the SPSS macro mediation and moderation analysis for repeated measures designs (MEMORE; Montoya & Hayes, 2017) and the R package rmcorr (Bakdash & Marusich, 2017). The significance level was α = .05 for all analyses. Our main focus was the difference in evaluations of healthiness and tastiness between the low and high color saturation product pictures, mediated by the products' perceived freshness.

4.2 | Results

4.2.1 | Correlations between healthiness, tastiness, and freshness

We first tested correlations between each two of the variables healthiness, tastiness, and freshness, using repeated measures correlations. Results revealed significant positive correlations between healthiness and tastiness, $r(6668) = .27$, $p < .001$, as well as between freshness and tastiness, $r(6668) = .40$, $p < .001$, and freshness and healthiness, $r(6668) = .32$, $p < .001$.

4.2.2 | The influence of color saturation on healthiness, tastiness, and freshness

The main hypothesis tested in Study 2 was that pictures of product packages would be judged as healthier, tastier, and fresher when presented with increased compared with decreased color saturation. To test this assumption, we conducted paired-samples t tests comparing participants' mean ratings of healthiness, tastiness, and freshness between the high and low package color saturation conditions. We

found small, but significant differences between the color saturation conditions for all three variables, healthiness, $t(170) = 3.135$; $p = .002$; $d = 0.08$, tastiness, $t(170) = 8.349$; $p < .001$; $d = .31$, and freshness, $t(170) = 6.573$; $p < .001$; $d = 0.28$. Supporting our hypothesis, product pictures were rated as significantly healthier (mean$_{high}$ [M_{high}] = 7.05, SD_{high} = 1.74; M_{low} = 6.91, SD_{low} = 1.79), tastier (M_{high} = 6.47, SD_{high} = 1.82; M_{low} = 5.88, SD_{low} = 1.96) and fresher (M_{high} = 6.28, SD_{high}= 1.93; M_{low} = 5.73, SD_{low} = 1.98) in the high saturation condition compared with the low saturation condition.

4.2.3 | Mediating effects of freshness perception

To test whether the effects of package color saturation on healthiness and tastiness were mediated by the perceived freshness of the product, we conducted within-participant mediation analyses using the MEM-ORE macro (Montoya & Hayes, 2017) for SPSS statistics software. We first tested a mediation model with package color saturation (high vs. low) as the independent variable, freshness as the mediator and healthiness as the outcome variable. The total effect of saturation on healthiness was significant, $b = 0.14$ ($SE = 0.05$), 95% CI (0.05–0.23). Moreover, the confidence interval of the indirect effect of saturation on healthiness via freshness did not include zero, $b = 0.10$ ($SE = 0.05$), 95% CI (0.01–0.20), indicating that freshness mediated the effect of saturation on healthiness. Further, the direct effect of saturation on healthiness was not significant, $b = 0.04$ ($SE = 0.05$), 95% CI (−0.06 to 0.13), indicating a full mediation. For a summary of the mediation model, including path coefficients, see Figure 1.

Next, we tested the mediation model with tastiness as an outcome variable, while saturation and freshness remained the independent variable and the mediator, respectively. The total effect of saturation on tastiness was significant, $b = 0.59$ ($SE = 0.07$), 95% CI [0.45–0.73]. Supporting a mediation model, the confidence interval of the indirect effect of saturation on tastiness via freshness did not include zero, $b = 0.32$ ($SE = 0.07$), 95% CI [0.19–0.46]. Yet, freshness did not fully mediate the effect of saturation on tastiness, as indicated by a significant direct effect of saturation on tastiness, $b = .26$ ($SE = 0.06$), 95% CI (0.15–0.38). For a summary of the mediation model, including path coefficients, see Figure 2.
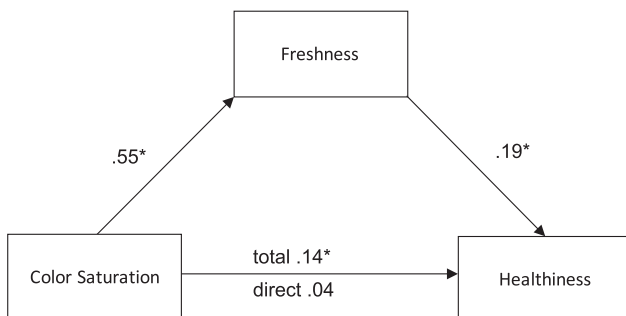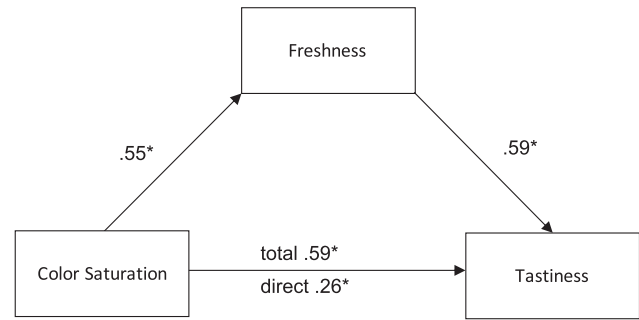

FIGURE 2 Summary of the results of the repeated measures mediation analysis, with tastiness as an outcome variable in Study 2

4.3 | Discussion

In Study 2, we found that a specific color cue on product packages, namely saturation, simultaneously affected the perceived healthiness and tastiness of products in the same way. Pictures of the same product packages were perceived as healthier and tastier when presented with increased compared with decreased color saturation and these effects were mediated by the perceived freshness of the products. However, the influence of saturation on healthiness was weaker ($d = 0.08$) than for tastiness ($d = 0.31$). Results of Study 2 support our argument that the same color cues on product packages can inform both consumers' healthiness and tastiness judgments in the same direction, but not necessarily to the same extent.

5 | GENERAL DISCUSSION

Across three studies we found a positive correlation between perceived healthiness and tastiness of food and drink products. The findings are in line with previous research (Haasova & Florack, 2019a; Werle et al., 2013) and further question the notion of a universal unhealthy=tasty intuition (Raghunathan et al., 2006) in consumer judgments. We assumed that this positive healthiness–tastiness relation is partly due to overlapping visual cues that consumers use for both judgment types and that one such cue is package color. Accordingly, we found that the variety of colors on product packages (full color vs. grayscale format) moderated the magnitude of the healthiness–tastiness relationship. Specifically, we showed that the strength of the association between healthiness and tastiness judgments shrunk when the color variety was reduced to grayscale. Generally, colors seem to help differentiate between the attractiveness of products and attractiveness itself is positively related to both healthiness and tastiness. We found that color did no longer influence the healthiness–tastiness relationship when we controlled for attractiveness.

We identified saturation as one particular color cue affecting both judgments, via its influence on perceived freshness. Products in vivid, color-saturated packages appeared fresher to consumers than products in muted, less color-saturated packages and fresh-looking

FIGURE 1 Summary of the results of the repeated measures mediation analysis, with healthiness as an outcome variable in Study 2

products were in turn evaluated as both healthier and tastier. However, the influence of saturation was stronger for tastiness than for healthiness, indicating that color does not influence both judgments to the same extent. We conclude from this that, whereas colors contribute to the healthiness–tastiness relationship because the same color cues (i.e., saturation) can indicate health and taste to consumers, they might be even more influential for tastiness judgments than for healthiness judgments.

5.1 | Practical implications

Lately, reducing colors to grayscale has been mentioned in the media in a different context. Various online newspapers and blogs recommended to turn smartphone screens to grayscale to make them less appealing (e.g., Bowles, 2018; Hern, 2017; Mikel, 2018). It is argued that reducing the colors might support users' self-control and lead to more mindful smartphone use, in part by reducing differences in attractiveness between apps (Mikel, 2018). Transferring this approach to the domain of healthy eating, one might ask whether grayscale has a positive effect on consumers' self-control by rendering tempting unhealthy food less appealing. However, this was not what we found. There was no negative healthiness–tastiness relationship to begin with, but a positive healthiness–tastiness relationship that was reduced when product pictures were viewed as grayscale images. Grayscale did not per se decrease the products' tastiness nor attractiveness, neither for those products rated as less healthy.[1] Thus, viewing pictures of unhealthy food only as grayscale images do not support consumers' self-control by decreasing the tastiness or attractiveness of unhealthy food.

An important implication of our studies for marketers is, that consumers' healthiness and tastiness evaluations of products are primarily congruent and that the same package cues can communicate healthiness and tastiness to consumers. This is especially relevant, because healthiness and tastiness are both crucial factors in food decision making (Johansen et al., 2011; Mai et al., 2014; Steptoe et al., 2013). We identified color saturation as one specific color cue that can increase a product's perceived healthiness and tastiness via freshness.

Results also indicate that colors are generally important for assessing the attractiveness of products, which is related to both healthiness and tastiness judgments. An important conclusion from this finding is, that healthiness, as well as tastiness, seem to depend to some extent on an intuitive impression of a product's overall attractiveness, as opposed to explicit health or nutrition labels. Accordingly, past studies found that explicit health claims

are irrelevant for many consumers in their food choices (Hieke & Grunert, 2017) and can even have negative effects on health and taste judgments (Huang & Lu, 2016).

5.2 | Limitations and future research

An important limitation of our research is that in Studies 1a and 1b, participants knew the products. Thus, they probably were able to fill in the missing color information with their brand knowledge. This might have led to an underestimation of the effect of our manipulation. Another limitation is that our measurement of products' tastiness is based on rating scales and that participants did not really taste any of the products. Therefore, the validity of our findings is restricted to the subjective expected tastiness of products based on external visual cues (i.e., color). Yet, in many instances in real life, consumers have to evaluate products merely based on their appearance, for example when examining products in a supermarket. Research findings indicate that the product choice in supermarkets mainly depends on visual cues (Schifferstein, Fenko, Desmet, Labbe, & Martin, 2013). Still, it would be highly interesting to test the effect of package color on the actual tasting experience of products. Future studies should test the influence of package color on the healthiness–tastiness relationship in real tasting experiments.

Eventually, we expected the colors on product packages to represent just one aspect of a larger and more complex set of available package cues used by consumers in forming product judgments. Future studies might test other relevant cues besides color that influence both a product's healthiness and tastiness and the association between the two.

5.3 | Conclusion

These studies yielded further support for the notion that the perceived healthiness and tastiness of food and drink products are positively related. We showed that package color, particularly color saturation, is one relevant cue contributing to the healthiness–tastiness association. Knowing the cues consumers use to judge products' healthiness and tastiness enables marketers to design food packages that promote healthier products as healthy and tasty at the same time, thereby encouraging more healthy food choices.

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[1]Using the data of Study 1b, we calculated an analysis of variance of the average tastiness per product as well as the average attractiveness per product, with package color (color vs. grayscale) and healthiness classification (healthy vs. unhealthy, obtained by means of a median split of the healthiness ratings) as independent variables. A differential effect of package color on subjectively healthy and unhealthy products would have been manifested in a significant interaction between healthiness classification and package color conditions. Yet, this interaction was not significant, neither for the dependent variable tastiness ($p = .83$), nor attractiveness ($p = .52$).

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