The impact of hue and saturation on consumer perceptions and responses in healthy food advertisements

Emma L. Fahner (s3381315)

Faculty of Behavioural Management and Social Sciences (BMS)

Master Thesis Communication Science

Dr. T.J.L. van Rompay

Drs. M.H. Tempelman

2 November, 2025

UNIVERSITY OF TWENTE.

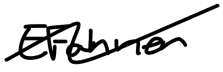
Declaration of academic integrity

I herewith declare that my master thesis is the result of my own work and that materials regarding the works of others, contributing to my master thesis, have been correctly cited and/or acknowledged.
I furthermore declare that I have taken notice of the principles and procedures regarding research ethics and academic integrity as presented in the UT Student Charter and on the website of the BMS Examination Board, or as mentioned otherwise during the course of my studies.
I finally declare that below actions regarding research ethics and academic integrity have been followed through:

1. In the case human test subjects were involved for data collection, I have filed a request for ethical review and my request has been approved by the BMS Ethics Committee
2. I have safeguarded the transmission of research files and documents, using my personal folder on the secure university network drive (P:\bms\cw\theses) or other means of safe data transmission.
3. I have stored my final master thesis and (raw) research data on my personal university network folder (P:\bms\cw\theses) or made it otherwise digitally available to my supervisors.
4. I have uploaded my draft master thesis, prior to the "green-light" meeting, for a plagiarism / similarity check on the M-COM Master Thesis Canvas website and I have shared the plagiarism / similarity report with my supervisors prior to the "green-light" meeting.
5. In the case AI generated content has been used, an appendix has been added in which I explain where and how AI generated content has been used for my master thesis (see info on University of Twente website).

Student name and signature:

Student name: Signature:

Emma Fahner 

Preface

In front of you is my master thesis: “The impact of hue and saturation on consumer perceptions and responses in healthy food advertisements.” I wrote this thesis as the final step for completing my Master’s program in Communication Science at the University of Twente.

During my bachelor's degree in Creative Business at Saxion University of Applied Sciences, I originally conceived the idea of researching the influence of color in advertising. Unfortunately, my graduation assignment did not require a formal thesis, so I had to keep this idea in the back of my mind. When the opportunity arose to choose a topic of interest for my master thesis, I immediately knew what to do. What was once a simple idea developed into a full-fledged master's thesis, and I could not be prouder.

I could not have completed this thesis without support, and I would like to express my gratitude. First, I want to thank all the participants who contributed to this research and volunteered to be part of it. Second, I want to thank Daniëlle Löwik-Telgenhof Oude Koehorst for lending me an Ishihara test. Third, I would like to thank my second supervisor, Mark Tempelman, for his valuable feedback and assistence. Lastly, I woud like to thank my first supervisor, Thomas van Rompay, who provided insightful advice, feedback, enthusiasm, helping to develop and refine this thesis into what you are about to read.

Finally, I would like to thank my friends and family for their overwhelming support and help throughout this journey. I dedicated a lot of time to this thesis, and while it was an enjoyable and fun process, it was not always easy. So, thank you for your motivating and inspiring words whenever I needed encouragement. I truly could not have done it without you.

I hope you enjoy reading my master’s thesis.

Emma Fahner

Abstract

Background: Worldwide, one in eight individuals is living with obesity. While the nutritional content of food plays a central role in determining its healthiness, consumers are frequently influenced by packaging and advertising when making purchasing decisions. Research indicates that color significantly affects consumer decisions, emotions, and perceptions of food quality. While previous studies have examined the effects of color in marketing, this study focuses on how variations in hue diversity and saturation level in healthy food advertisements influence consumers' perceptions of naturalness, emotional responses, attitudes and brand impressions. ***Methods:*** To explore these influences, the study used a 2 (hue diversity: low versus high) × 2 (color saturation: low versus high) × 2 (sensitivity to design: low versus high) between-subjects design, where participants were exposed to different advertisements. ***Results:*** The results show that both a low hue diversity and low saturation level positively influence perception of naturalness. Additionally, the study shows that the use of low saturated colors can make a brand appear more sincere. In contrast, design sensitivity had no direct effect, but appeared only to be significant in an interaction effect with hue diversity on Ruggedness. ***Conclusion:*** Color plays a central role in determining perception of naturalness. This study underscores the power of color as a subtle yet influential communication tool in healthy food advertising. By understanding how variations in hue diversity and saturation level affect consumers' perceptions, marketers can use this knowledge to create effective advertising strategies to promote healthy foods, which may ultimately help mitigate the global health crisis of overweight and obesity.

Keywords: color psychology, food advertising, perception of naturalness, consumer responses, color perception

Table of Contents

1. Introduction

Food is one of the most important factors in maintaining overall health (World Health Organization, 2002). Malnutrition, in all its forms—including obesity, undernutrition, and other dietary risks—is the leading cause of poor health worldwide (Swinburn et al., 2019). In 2022, 2.5 billion adults (aged 18 years and older) were classified as overweight, with 890 million of them living with obesity. Additionally, 427 million children (aged 0-19) were also overweight, including 160 million who were considered obese. Obesity is a global health crisis, with one in eight individuals worldwide living with obesity (World Health Organization, 2024). Not only is obesity a significant health issue and can increase the risk of many health problems (e.g., diabetes, high blood pressure, heart disease) (National Institute of Diabetes and Digestive and Kidney Diseases, n.d.), but it also carries considerable economic implications. In 2019, the average expected cost of obesity was estimated at 2.19% of GDP across 161 countries (Okunogbe et al., 2022). While the nutritional content of food plays a central role in determining its healthiness, consumers are frequently influenced by packaging and advertising when making purchasing decisions. Research has shown that color significantly impacts consumer choices regarding food products (Pathare et al., 2013; Spence, 2015; Altmann et al., 2023). At the point of purchase, consumers often rely on visual cues to assess the freshness and flavor quality of food (Pathare et al., 2013). Marketers face the challenge of effectively communicating health benefits and naturalness in ways that resonate with consumers.

In marketing communication, color is not only a valuable tool but also an integral element (Bytyçi, 2020). Colors significantly impact perceptions (Bagchi & Cheema, 2013) and can influence moods, emotions, cognitions, and sensations (Singh & Srivastava, 2011). In addition, color can also affect how consumers perceive a brand. For instance, hue diversity

and saturation can enhance the vividness, dynamism, and engagement of a brand's visual presentation, thereby strengthening positive brand impressions (Labrecque & Milne, 2012).

Variations in hue and saturation have also been shown to affect perceptions of naturalness in other contexts. Zhang et al. (2024) explored how color saturation influences tourists' perceptions. They found that based on principles of color psychology and consumer beliefs, reducing the color saturation in marketing materials can enhance the perceived naturalness of a destination. Berman et al. (2014) discovered that variations in hue, particularly hue diversity, significantly influence perceptions of naturalness. Scenes with lower hue diversity—characterized by more uniform and harmonious color distributions—are perceived as more natural. This suggests that subtle variations in color hue and saturation contribute to feelings of naturalness.

In food marketing, the perception of naturalness is particularly important, as it affects consumers' views on product quality and health benefits. It is an important factor in consumer acceptance of food. It affects preferences for organic, traditional, and locally-produced foods, which are often considered healthier options (Román et al., 2017). While many studies have examined how color affects consumer behavior, they tend to focus mainly on individual colors rather than combinations (Labrecque, 2020). Therefore, there is a need to explore the impact of more complex color schemes, as advertising uses a combination of mulitiple colors. Additionally, despite the growing body of research on color psychology and its impact on consumer behavior, the relationship between color and the perception of naturalness in the context of healthy food advertisements remains largely unexplored. This study aims to fill this gap by examining how variations in hue and saturation influence consumer perceptions of naturalness, emotional responses, attitude, and brand impressions in healthy food advertisements.

In addition to its scientific contributions, this research has potential societal benefits. Consumers are constantly exposed to advertisements and information. Food plays a crucial role in maintaining overall health (World Health Organization, 2002). Many consumers like to eat unprocessed and natural foods. At the same time, they also want to save cooking time and buy convenience food (Román et al., 2017). Therefore, effectively communicating information about healthy foods is vital for encouraging healthier eating habits.

The central question addressed in this research is: *How do variations in hue and saturation of colors used in healthy food advertisements influence consumer perceptions of naturalness, their emotional responses, attitudes, and brand impressions?* According to Bloch et al. (2003) consumers vary in the extent to which they pay attention to, or are influenced by design–in this study, the variations in hue and saturation. In order to account for individual differences, this study also incorporates sensitivity to design. To test this research question, an experiment with a 2 (hue diversity: low versus high) × 2 (color saturation: low versus high) × 2 (sensitivity to design: low versus high) between-subjects design was employed in which participants were exposed to different food advertisements. By understanding how variations in hue and saturation affect consumers' perceptions of naturalness, emotional responses, attitudes and brand impressions, marketers can use this knowledge to create effective advertising strategies to promote healthy foods, which may ultimately help mitigate the global health crisis of overweight and obesity.

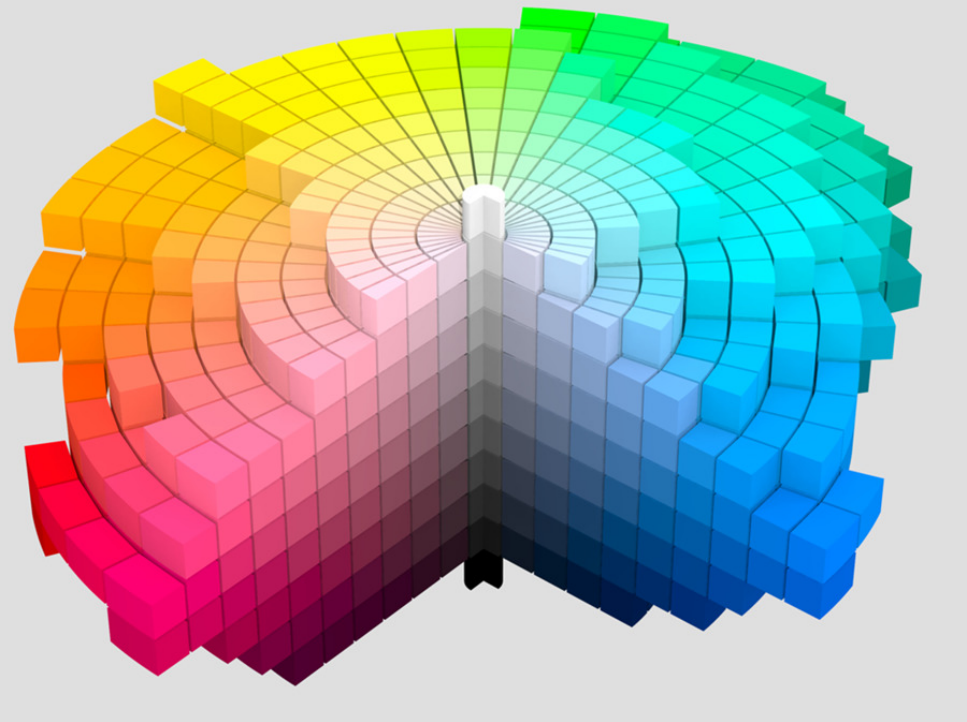
2. Theoretical framework

Colors play an important role in impacting perceptions (Bagchi & Cheema, 2013) and can influence moods, emotions, cognitions, and sensations (Singh & Srivastava, 2011). For instance, a study by Modi et al. (2019) indicates that the color red is associated with an increase in blood pressure, whereas blue is linked to a decrease in blood pressure. However, it is important to note that color perceptions vary among individuals and are influenced by factors such as gender, age, and culture (Bortoli & Maroto, 2001). Color-emotion associations, on the contrary, are a psychological universal that likely enhances shared communication and understanding (Jonauskaite et al., 2020).

Color can be described through three dimensions: hue, saturation, and value (HSV). Hue refers to the wavelength composition of a color, saturation indicates the intensity, richness, strength, or purity of that color, and value represents the relative lightness or darkness. It is important to note that different hues have varying maximum saturation levels; some hues can achieve higher saturation than others, as shown in Figure 1 (Labrecque, 2020). This study focuses specifically on hue and saturation.

Figure 1

Munsell color system



2.1 Color in visual marketing communication

Advertising significantly influences customer behavior by shaping their perceptions, attitudes, and purchasing decisions (Soti, 2022). The importance of visual perception in marketing and advertising—including elements such as shapes, forms, colors, materials, textures, graphical components, and logos—has been widely acknowledged (Zailskaitė-Jakštė et al., 2017).

In the realm of food advertising, research demonstrates that color plays a crucial role in influencing consumer choices regarding food products (Pathare et al., 2013; Spence, 2015; Altmann et al., 2023). At the point of purchase, consumers often rely on visual cues to evaluate the freshness and flavor quality of food (Pathare et al., 2013). Bielaszka et al. (2024) examined the impact of color on dietitians' food preferences by focusing on selected tomato

juices. They found that color is particularly important in the selection of food products and significantly influences dietitians' preferences and dietary choices. A specific color can evoke either positive or negative associations for dietitians. For instance, Liu et al. (2022) highlight the specific role of high (vs. low) color saturation in shaping positive perceptions of freshness and tastiness in food imagery. Paakki et al. (2019) discovered that mixed salads with high colorfulness and contrast are perceived as more visually appealing compared to those with pale colors and no contrast. In food marketing, product freshness and tastiness are key attributes that drive consumer interest (Liu et al., 2022).

In conclusion, color plays a crucial role in food advertising by shaping consumer perceptions. Research indicates that visual cues, particularly hue and saturation, significantly affect how consumers evaluate food products, including their perceived freshness, tastiness, and naturalness. Therefore, understanding the psychological impact of color can help marketers create more effective advertisements that resonate with consumer preferences and enhance marketing efforts.

2.2 Perception of naturalness

Sensory characteristics influence the perceived naturalness of a product (Dantec et al., 2022). For intance, color can indicate food quality, such as the ripening process or the visible signs of spoilage (Pathare et al., 2013). Roman et al. (2017) note that foods perceived as natural by consumers are generally considered healthier. Furthermore, the perceived naturalness of a product positively correlates with its attractiveness, quality, credibility, and intent to purchase (Binninger, 2015). Consumers tend to view food as more natural when it looks appealing, believing that this naturalness signifies healthiness (Hagen, 2020). Additionally, humans have a tendency to prefer natural things (Wilson, 1984). This makes naturalness a key characteristic in product evaluation.

Berman et al. (2014) discovered that variations in hue, particularly hue diversity, significantly influence perceptions of naturalness. Scenes with lower hue diversity—characterized by more uniform and harmonious color distributions—are perceived as more natural. While Spence (2015) did not measure perception of naturalness, this study observed that increasing the color variety in food can lead to a suppression of appetitive behaviors when associated with off-colors. Similarly, Pathare et al. (2013) show that consumers have color preferences for a specific food item. Colors that are inappropriate for a particular item indicate a loss of freshness or suggest a lack of ripeness, which can turn away potential consumers. Although, only Berman et al. (2014) focus on hue diversity and the perception of naturalness, other research suggests that unexpected or inappropriate color variation can reduce positive food evaluations (Spence, 2015; Pathare et al., 2013). This could suggest that a greater hue diversity may negatively affect perceived naturalness.

In contrast, there has been more evidence of the influence of saturation on the perception of naturalness. A study on how consumers evaluate visual stimuli has revealed that color saturation influences their perception of color naturalness (Nakano et al., 2009). Generally, consumers show a preference for products with high saturated colors (Huang et al., 2023). However, while high-saturation colors may be visually appealing, they can also appear artificial. Moreover, consumers are more likely to perceive low-saturation colors as more natural (Huang, 2021). Extending on this, Zhang et al. (2024) explored how color saturation influences tourists' perceptions and purchase intentions. They found that based on principles of color psychology and consumer beliefs, reducing the color saturation in marketing materials can enhance the perceived naturalness of a destination. Considering these studies, it is suggested that both hue diversity and saturation influence the perception of naturalness. Therefore, this study argues:

H_1: Low (vs. high) hue diversity in food advertisements positively affects perception of naturalness.

H_2: Low (vs. high) saturation levels in food advertisements positively affect perception of naturalness.

2.3 Emotional response

The way individuals perceive colors and the emotions those colors evoke can vary significantly based on personal and cultural influences (Cakmak et al., 2024). For instance, while red is often considered "lucky" by participants in China, participants in the UK may associate luck with the color green (Chen et al., 2020). Despite these differences, there are common associations with colors. According to Chen et al. (2020), cool colors like blue and green are typically linked to calm, serene, and comforting moods. In contrast, warm colors such as red and orange tend to be associated with more stressful and exciting emotions.

A study conducted by Shagyrov and Shamoi (2024) explored how logo colors influence consumer perception and emotional responses. Their findings reveal that colors influence how consumers perceive and emotionally respond to food brands. Additionally, it confirms specific associations between colors and emotions, such as yellow being linked to happiness, blue to sadness, and bright colors to surprise.

Wilms and Oberfeld (2018) mention that color systematically affects emotional states, including arousal and valence, skin conductance responses, and heart rate, after merely seeing a color. They found that the saturation of a color provokes emotional responses. Higher saturated colors are perceived as more pleasant, experienced as more arousing, and more likely to grab attention (Valdez & Mehrabian, 1994; Zieliński, 2016). Similarly, Song et al. (2025) highlighted that highly saturated colors are generally associated with more positive emotions. Based on the study of Sheng (2024), which examined the visual image design of a

food brand, an interesting design scheme was proposed based on emotional design theory. This design includes the use of interesting patterns and bright colors, providing consumers with a unique interactive experience. Notably, using highly saturated colors can become an important factor in stimulating visual appeal and increasing consumer attention and emotional responses.

In this study, emotional response refers to the consumer's affective reaction or feeling toward a product after viewing an advertisement. This emotional response reflects the extent to which the advertisement makes a consumer feel emotions such as excitement or interest about the product. Drawing on prior literature, this study argues that using a wide range of hues in food advertisements, can create visually stimulating and engaging designs, which could lead to positive feelings toward the product. Additionally, colors with high saturation tend to be more vibrant and intense. These colors are also expected to enhance positive feelings toward the product. Thus, this study hypothesizes:

H_3: High (vs. low) hue diversity in food advertisements positively affects emotional response, reflected in feeling, towards the product.

H_4: High (vs. low) saturation levels in food advertisements positively affect emotional response, reflected in feeling, towards the product.

2.4 Attitude

Attitude in this study refers to how an individual thinks about a product. According to Singh (2006), color generates positive or negative evaluations and plays a role in forming consumers' attitudes, for instance, appeal or interest towards a product. Affective responses elicited by colors can also shape cognitive responses. Positive feelings such as happiness or excitement have been shown to spill over into more favorable attitudes toward advertisements and brands, in terms of liking. (Batra & Ray, 1986; Edell & Burke, 1987).

Bezaz and Kacha (2021) showed the effect of packaging color on children's evaluation of packaging and attitude towards the brand. The study concluded that a high (vs. low) saturation level influenced children to evaluate the packaging significantly more positively. As a result, children also showed more positive attitudes towards the brand, particularly in terms of their feelings of liking and enjoyment.

Building on this, this study argues that variations in hue diversity and saturation level influence consumers' attitudes toward the product. Specifically, a wide range of hues can make a design appear more engaging and stimulating, potentially increasing the product's appeal, pleasantness, and enjoyment. Similarly, high saturation levels can create a more visually appealing appearance and evoke a sense of energy by enhancing the intensity and vividness of colors, resulting in more positive attitudes. Therefore, this study argues:

H_5: High (vs. low) hue diversity in food advertisements positively affects attitude towards the product.

H_6: High (vs. low) saturation levels in food advertisements positively affect attitude towards the product.

2.5 Brand impressions

Color plays a crucial role in shaping brand identity and influencing consumer perceptions. It serves as a symbol representing a brand's core characteristics. Essentially, a brand's color acts as a form of information encoding that communicates key brand attributes to consumers. It helps shape impressions based on individual experiences with the brand (known as brand image) and gathers feedback through evaluations that guide updates to overall brand knowledge (referred to as brand reputation) (Tang & Chen, 2024).

Labrecque and Milne (2012) illustrate the connection between color hue and brand personality. The choice of hue significantly influences how consumers perceive a brand's

personality due to its inherent meanings. For instance, red evokes excitement, blue conveys a sense of competence, black and purple suggest sophistication, and brown reflects ruggedness. By carefully selecting hues that align with the desired traits of a brand, marketers can effectively communicate the brand's personality to consumers. Moreover, Kim and Sung (2010) reveal that colors significantly affect four dimensions of brand personality: Sincerity, Excitement, Competence, and Ruggedness. Specifically, they found that both the sincere and exciting traits of a brand are influenced by the color yellow, while traits associated with competence, sophistication, and ruggedness are strongly linked to the color red. So, a higher hue diversity may create a more dynamic and engaging visual experience, which could enhance brand impressions associated with the brand personality dimensions.

Additionally, saturation has a significant impact on brand personality (Labrecque & Milne, 2012). Research indicates that both saturation and value have a greater effect on consumers' perceptions of brand image than hue (Ghaderi et al., 2015). High saturation evokes feelings of dynamism and liveliness, influencing the perceived personality traits of individuals and brands. Increasing the saturation in a logo's color redesign enhances the perception of brand energy, which in turn improves brand attitude (Kawamata & Moriguchi, 2024). According to Labrecque and Milne (2012), high saturation consistently conveys more vivid and intense brand imagery, enhancing perceptions of arousal and dominance. As a result, high saturation is associated with traits like Excitement, Competence, and Ruggedness. In contrast, low saturation is linked to attributes such as Sophistication and possibly Sincerity, as low saturation colors provide a muted, natural appearance. With these studies in mind, this research poses the following question:

RQ_1: How do hue diversity and saturation levels affect perceptions of brand personality dimensions?

2.6 Price expectancy

While this study primarily examines how hue and saturation influence perceptions of naturalness, emotional responses, attitudes, and brand impressions in healthy food advertisements, it is also interested in consumers' price expectancy of the product featured in the advertisement. Previous research indicates that consumers often perceive healthier foods as more expensive. For instance, Haws et al. (2017) found that consumers believe that healthier food is more expensive than less healthy foods. Similarly, Jo and Lusk (2018) found that both in the US and South Korea, consumers perceive healthier foods as more expensive when they received neutral or negative health information about the healthfulness of the product. Bower et al. (2003) highlighted that the main reasons for buying and not buying a fat spread with health benefits were its perceived healthiness and high price. In addition, they argued that potential health benefits for consumers may increase the price of such products.

This belief that healthier foods are more expensive is further supported. Bolarić et al. (2013) confirmed that low nutritional quality food costs less and its price is more resistant to inflation. A study on how low-income parents evaluate the cost of food proved that healthy eating is financially burdensome (Daniel, 2020). Waterlander et al. (2010) further illustrate that food selection is not based on preferences but on cutting down expenses.

Building on these insights, this study investigates whether visual cues like hue diversity and saturation level in healthy food advertisements also shape consumers' price expectations:

RQ_2: How do hue diversity and saturation levels in healthy food advertisements affect consumers' price expectancy?

2.7 Sensitivity to design, as a moderator

Visual elements play a crucial role in shaping how advertisements are perceived and evaluated. However, consumers respond differently to advertising stimuli (Verma, 2009). Research indicates that the impact of packaging design on the food experience varies based on consumers' sensitivity to design (Becker et al., 2011). Bloch et al. (2003) developed a scale to measure individual differences in the importance of visual product aesthetics to account for this. This scale evaluates three aspects: the ability to recognize design (acumen), the importance placed on design (value), and reactions to design (response). Individuals with high design sensitivity may interpret hue diversity and saturation differently, perceiving certain visual cues as either enhancing or detracting from a product's perception of naturalness, emotional response, attitude or brand impressions. It could also be argued that individuals with a lower sensitivity to design do not notice these subtle differences in variations of hue and saturation. Thus, sensitivity to design may moderate how consumers respond to the visual characteristics of healthy food advertisements:

> *H_7: The effects of hue diversity and saturation in healthy food advertisements on perceived naturalness, emotional response, attitude, and brand impressions will be stronger for consumers with high sensitivity to design, compared to those with low sensitivity to design.*

2.8 Eating habits, as a covariate

An individual's dietary choices have a significant impact on their health. Poor dietary habits are linked to various chronic diseases and can potentially be a major contributor to Non-Communicable Diseases (NCD) mortality worldwide (Afshin et al., 2019). Key determinants of general food choices can be identified and classified into several categories. These include factors related to the food itself, such as sensory and perceptual characteristics; external

influences like information and environment; personal traits including biology and psychology; cognitive aspects such as knowledge and preferences; and sociocultural elements like culture and economic conditions (Cheikh Ismail et al., 2025). Among these determinants, product familiarity and established routines play a significant role in shaping food choices (Pater et al, 2025). This means that individuals who consume a healthy diet may respond more positively to advertisements for healthy products than people who follow a less healthy diet. Therefore, this study considers eating habits as a control variable. By measuring eating habits, this study can more accurately assess the relationship between hue diversity and saturation and the outcome variables, reducing the risk of confounding effects due to variations in dietary behavior.

> *H_8: Individuals who consume a healthy diet may respond more positively to advertisements for healthy products than people who follow a less healthy diet.*

2.9 Interaction effects

While the previous hypotheses focus on the main effects of hue diversity and saturation, it is important to note that color perception does not operate in isolation. For instance, the emotional impact of a color is not determined solely by its hue but rather by the combination of hue, saturation, and brightness (Wilms & Oberfeld, 2018). In addition, Dael et al. (2016) suggest that saturation interacts with the other color dimensions, such as hue and brightness, in influencing affective processing. This may suggest that hue diversity and saturation may interact to influence how consumers respond to healthy food advertisements. Arguably, the effects of variations in hue diversity could be stronger when the colors are highly saturated, as they appear more vivid and vibrant. Therefore, this study considers an exploratory research question for interaction effects:

RQ_3: How do hue diversity and saturation level interact, alongside sensitivity to design and eating habits, to shape perceptions of naturalness, emotional response, attitude, and brand impressions?

2.10 Conceptual model

To summarize the theoretical framework, a conceptual model can be designed, as illustrated in Figure 2. This study aims to evaluate the hypotheses and investigate how variations in hue diversity and saturation of colors in healthy food advertisements influence consumer perceptions of naturalness, emotional response, attitude, and brand impressions, as well as the interplay among these factors. Additionally, the study considers the effect of sensitivity to design (as moderator) and eating habits (as covariate). Lastly, it will explore how healthy food advertisements impact consumers' price expectancy.

Figure 2

Conceptual model of the impact of hue diversity and saturation

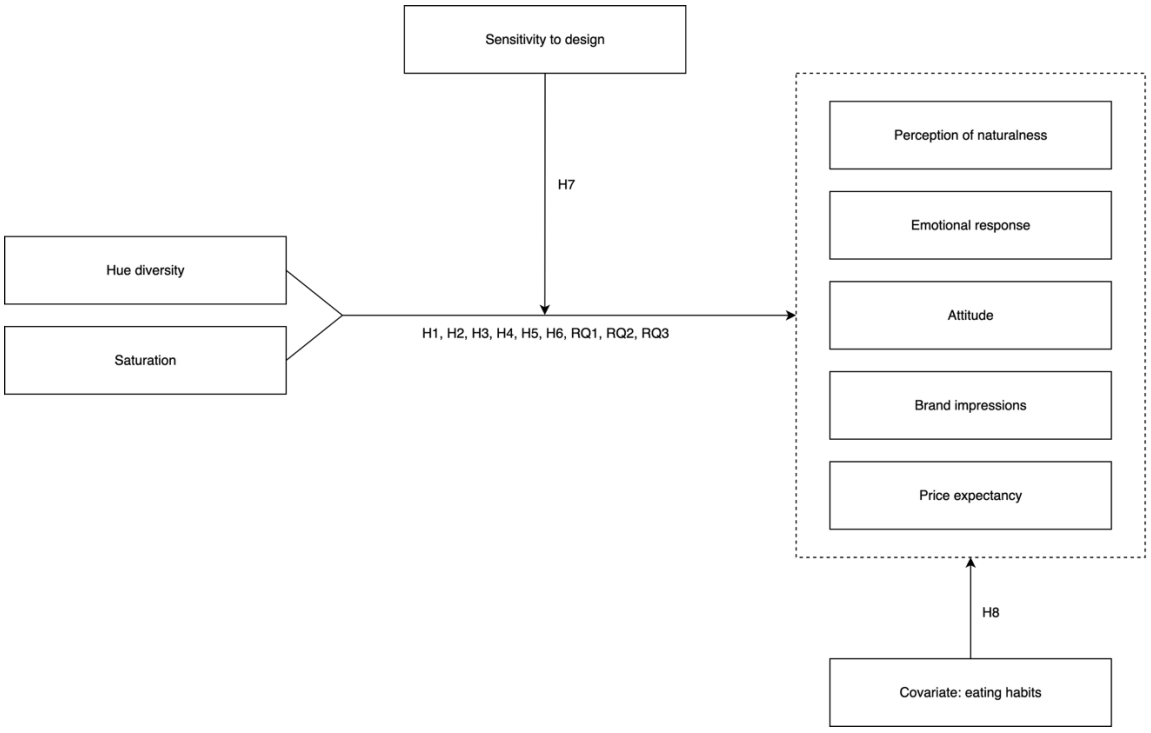


Table 1

Overview of hypotheses and research questions

Hypotheses / research questions	
H1	Low (vs. high) hue diversity in food advertisements positively affects perception of naturalness.
H2	Low (vs. high) saturation levels in food advertisements positively affect perception of naturalness.
H3	High (vs. low) hue diversity in food advertisements positively affects emotional response, reflected in feeling, towards the product.
H4	High (vs. low) saturation levels in food advertisements positively affect emotional response, reflected in feeling, towards the product.
H5	High (vs. low) hue diversity in food advertisements positively affects attitude towards the product.
H6	High (vs. low) saturation levels in food advertisements positively affect attitude towards the product.
H7	The effects of hue diversity and saturation in healthy food advertisements on perceived naturalness, emotional response, attitude, and brand impressions will be stronger for consumers with high sensitivity to design, compared to those with low sensitivity to design.
H8	Individuals who consume a healthy diet may respond more positively to advertisements for healthy products than people who follow a less healthy diet.
RQ1	How do hue diversity and saturation levels affect perceptions of brand personality dimensions?
RQ2	How do hue diversity and saturation levels in healthy food advertisements affect consumers' price expectancy?
RQ3	How do hue diversity and saturation level interact, alongside sensitivity to design and eating habits, to shape perceptions of naturalness, emotional response, attitude, and brand impressions?

3. Methodology

3.1 Research design

This study utilized a quantitative approach to investigate how variations in hue and saturation of colors used in healthy food advertisements influence consumer perceptions of naturalness, emotional responses, attitudes, and brand impressions. The objective was to better understand consumer behavior. The research method involved an experiment where participants were shown different sets of stimuli, each with variations in hue diversity and saturation. The advertisements featured two to five distinct colors, presented at two levels of saturation: low and high, ensuring perceptually noticeable differences that align with realistic advertising designs. This results in a 2 (hue diversity: low versus high) × 2 (color saturation: low, high) × 2 (sensitivity to design: low versus high) between-subjects design.

3.2 Development of stimuli design

3.2.1 Type of product

The stimuli used for this experiment consisted of an advertisement featuring a product that could be perceived as both healthy and unhealthy. To avoid bias, it was important that the stimuli did not include photographs of actual foods. As a result, it was decided to showcase a drink. With the increasing focus on nutrition and the growing popularity of high-protein products (Kale, 2021; Denniss et al., 2023; Scheres, 2024), the stimuli considered for this study included advertisement posters from a fictional company promoting a protein lemonade. A pre-test was conducted to validate whether this product was recognized and relevant for this study to feature on the stimuli, and to compare it with alternative drinks, such as a vitamin drink and an electrolytes drink. The results indicated that while all three drink types were familiar to the participants to varying degrees, vitamin drinks were the most

recognized (see Table 2). Protein lemonade and electrolyte drinks were strongly associated with sports, recovery, and health-focused consumption, whereas vitamin drinks were primarily associated with soft drinks, which may diminish their perceived healthiness. Table 2 shows that protein lemonade achieved the highest fit for ad score, suggesting that participants found it the most appropriate product for an advertisement. Additionally, participants found protein lemonade to be the most appealing option among the three drinks. Although protein lemonade was not the most recognized, it emerged as the most relevant choice for this study based on the overall results. Therefore, a protein lemonade from a fictional company was selected to be featured on the stimuli. See Appendix A for more detailed information regarding the pre-test procedure and results.

Table 2

Familiarity, Advertisement Fit, and Health Perception Ratings per drink

	n	Mean	SD
Protein lemonade			
Familiraty [a)]	26	2.62	1.27
Fit for ad [b)]	26	3.42	0.99
Targeted at healthy consumers [b)]	26	4.12	0.77
Vitamin drink			
Familiraty [a)]	26	3.46	0.91
Fit for ad [b)]	26	2.77	0.95
Targeted at healthy consumers [b)]	26	3.27	1.15
Electrolytes drink			
Familiraty [a)]	26	2.62	1.27
Fit for ad [b)]	26	3.19	0.80
Targeted at healthy consumers [b)]	26	3.58	0.90

a) 5-point liker scale (1=not familar at all / 5=very familiar)

b) 5-point liker scale (1=totally disagree / 5=totally agree)

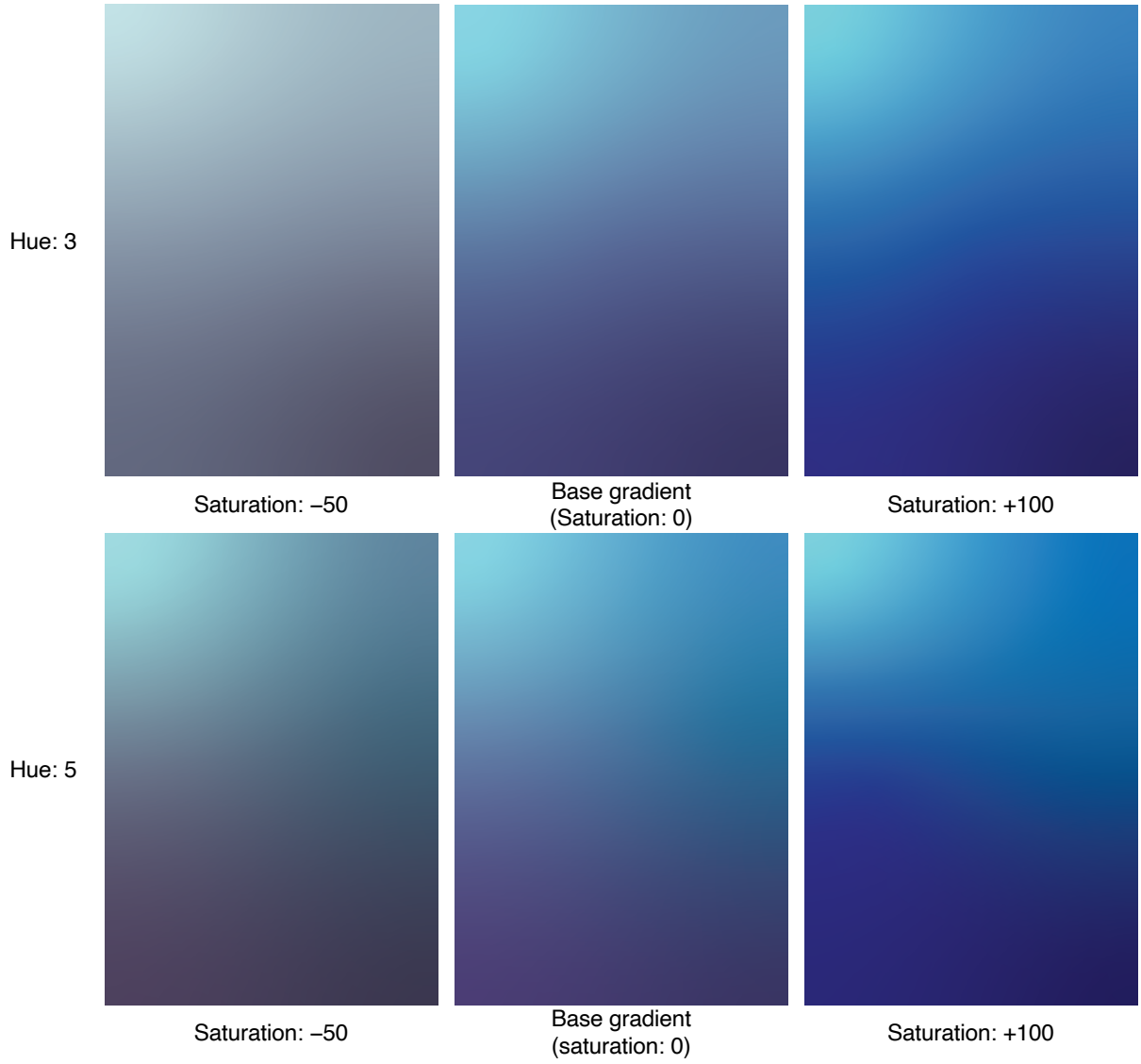
3.2.2 Background of the advertisement

The background of the stimuli was what would contain the manipulation in hue and saturation. In order to have multiple hues in the background, it was decided to create a

gradient consisting of three or five colors. After creating two base gradients, the saturation could be changed. From the base designs, the saturation setting in Adobe Illustrator was set to +100 for the high level and −50 for the low level (see Figure 3). It was decided to go for −50 because, with this setting, the background would still have some color, while with the saturation setting set to −100, the background would be almost completely gray-scaled and not give a realistic feel. Informal interviews were conducted in order to ensure participants could see a difference between the two backgrounds. During these interviews, individuals were asked how many colors they saw at each of the six backgrounds. They could estimate a number close to the amount of hues used, or they could identify the exact number. When asked if they saw a difference when all six backgrounds were shown, they mentioned that they did. However, to make the distinction between the two gradients even more profound, it was decided to go for a hue variation of two versus five.

Figure 3

Gradient backgrounds with different hue variations (3 / 5) and saturations (+100 / –50)



The colors in the stimuli—orange for the bottle and the blue tints for the background—were chosen because they are complementary colors, meaning these colors are on opposite sides of the color wheel (Pridmore, 2021). The final step in creating the stimuli involved designing a mock-up to simulate a realistic setting. The final stimuli used in this study can be found in Figure 4. It was essential that the stimuli were not seen digitally by participants, as colors display differently across different screens. Therefore, the stimuli were printed professionally.

Figure 4

Final stimuli used in experiment

Stimuli K (Low hue × Low saturation)

Stimuli M (Low hue × High saturation)

Stimuli N (High hue × Low saturation)

Stimuli P (High hue × High saturation)

3.3 Measurement scales

In order to measure the various variables, existing scales were be adapted where possible. Similar to the stimuli, these statements underwent pre-testing through think-aloud tests to ensure clarity and relevance. Participants received the survey and were asked to complete it, providing feedback on any unclear items or comments they had. The pre-test resulted in adjustments to the wording of some items, leading to the final measures used in the experiment. Please refer to Appendix B for full item list.

To assess the study's reliability, the scales' reliability was evaluated through the calculation of Cronbach's alpha, and Spearman-Brown coefficient together with the

standardized coefficient alpha for scales consisting of two items, as it is the most appropriate reliability statistic for a two-item scale (Eisinga et al., 2013) (see Appendix C for full overview).

3.3.1 Perception of naturalness

The perception of naturalness refers to how consumers view a product's natural qualities after seeing advertisements. This study used adapted items to measure perception of naturalness, drawing on research from Van Rompay et al. (2016). The scale included the following descriptors: pure, fresh, natural, healthy, wholesome, and honest. Participants rated these items using a 7-point Likert scale, ranging from "Not at all" to "Completely so." Example items used to evaluate the perception of naturalness were: "This advertisement suggests that this is a healthy product.", "This advertisement suggests that this is a pure product" and "This advertisement suggests that this is a fresh product" ($\alpha = 0.78$).

3.3.2 Attitude

Attitude in this study refers to how a consumer thinks about a product. To assess how the participant thinks about the product, this study measured the consumer's attitude after viewing advertisements using a 7-point bipolar scale. This scale, which ranges from negative to positive, has been adapted from the works of Babin & Burns (1997), Bezjian-Avery et al. (1998), Keller (1991), Kelleris et al. (1993), Singh et al. (2000), and Tavassoli & Lee (2003). The scale included dimensions such as unappealing to appealing, would not like to try to would like to try, and unenjoyable to enjoyable, among others. It also included a self-created item ranging from not refreshing to refreshing ($\alpha = 0.91$).

3.3.3 Emotional response (feeling)

The emotional response examined in this study focuses on the feelings evoked by the advertisement. To assess how the participants feel about the product, this study employed feelings scales used by Edell and Burke (1987), selecting the most appropriate items for this context that reflected positive emotions. Additionally, due to the concerns identified in the pretest, skepticism was also included. Participants rated these items using a 7-point Likert scale ranging from 'Strongly disagree' to 'Strongly agree.' Example items used were: "The advertisement made me feel excited (about the product)", "The advertisement made me feel interested (about the product)", and "The advertisement made me feel happy (about the product)." *Feeling_8* was excluded from further analysis because this item negatively affected the Cronbach's alpha ($\alpha = 0.90$).

3.3.4 Brand impressions

In this study, brand impressions refer to the attitudes participants have after viewing the stimuli. The items used to measure these impressions were adapted from Aaker's (1997) five dimensions of brand personality. Although this scale has received criticism regarding its validity (Azoulay & Kapferer, 2003), it remains the standard method for measuring brand personality (Keller & Lehmann, 2006). As mentioned earlier, many studies illustrate the correlation between color and brand personality using these dimensions, making this scale the most appropriate for assessing these effects. The scale included the dimensions Sincerity, Excitement, Competence, Sophistication and Ruggedness. Participants rated these items using a 7-point Likert scale, which ranges from 'Strongly disagree' to 'Strongly agree.' Example items used were: "This advertisement suggest that this brand is honest" (Sincerity), "This advertisement suggests that this brand is daring" (Excitement), "This advertisement suggests that this brand is reliable" (Competence), "This advertisement suggests that this

brand is charming" (Sophistication) and "This advertisement suggest that this brand is tough" (Ruggedness). The reliabilities for three dimensions were acceptable (Sincerity $\alpha = 0.76$, Excitement $\alpha = 0.70$, and Competence $\alpha = 0.80$). However, *Sincerity_2* was excluded from further analysis because this item negatively affected the Cronbach's alpha. For the dimension of Sophistication, the inter-item correlation was $r = 0.43$ ($\alpha = 0.60$), and for Ruggedness, the correlation was $r = 0.35$ ($\alpha = 0.52$). These results indicate limited internal consistency. However, a low value of alpha could also be due to a low number of items (Tavakol & Dennick, 2011). Consequently, results involving these dimensions should be interpreted with caution.

3.3.5 Price expectancy

Price expectancy refers to the amount participants believe the product featured in the advertisement would cost. This was measured using an open-ended question asking participants to indicate the expected price in euros.

3.3.6 Sensitivity to design

In this study, sensitivity to design refers to the degree to which an individual is aware of, influenced by, and appreciative of the aesthetic and stylistic elements in advertisements. This concept reflects a person's tendency to notice and respond positively or negatively to visual design features, including color, typography, layout, composition, and overall artistic quality. To measure participants' sensitivity to design, this study utilized adapted items from the "Individual Differences in the Centrality of Visual Product Aesthetics" scale (Bloch et al., 2003). This scale evaluates three aspects: the ability to recognize design (acumen), the importance placed on design (value), and reactions to design (response). While the original

scale consists of eleven items, this study utilized ten modified items focusing on advertisement design rather than product design. The items will be measured using a 7-point Likert scale ranging from “Not at all” to “Very much so”. Example items used: “An advertisement's design is a source of pleasure for me” (acumen), “I enjoy seeing displays of advertisements that have superior designs” (value), “If an advertisement's design really “speaks” to me, I feel that I must buy the product” (response) ($\alpha = 0.90$).

3.3.7 Eating habits

Eating habits were measured by adapting a scale by Żakowska-Biemans et al. (2019). This scale consists of ten statements related to the choice of food that is healthy, nutritious, natural, and in general indicating a balanced diet. Participants rated these items using a 7-point Likert scale, ranging from “Never” to “Always.” Example items used to evaluate the eating habits were: “I choose food that is nutritious” and “I choose food that contains a lot of vitamins and minerals.” *Eating_habits_3* was excluded from further analysis because this item negatively affected the Cronbach’s alpha ($\alpha = 0.83$).

3.4 Procedure

Before the data collection phase, the research was submitted to the BMS ethics committee of the University of Twente for an ethical assessment to ensure an ethically responsible research practice. Ethical approval was obtained on May 22, 2025 (see Appendix D). To uphold ethical responsibility, participants were informed about the purpose of the study to a reasonable extent, ensuring that this information did not influence their responses. Additionally, they were required to sign an informed consent form (see Appendix E), which stated that their participation was entirely voluntary, that they could withdraw from the study

at any time and for any reason—without needing to justify their decision—and that they had the right to request the removal of their data from the dataset at any time. If participants chose not to sign the informed consent form, they would not participate in the experiment.

Before the actual experiment, participants were screened for color blindness, as individuals with this condition cannot accurately identify or distinguish between different hues (Heywood et al., 1998). Since some people may not be aware they are color blind, conducting a formal test is more effective than simply asking them if they have a color vision deficiency. This was done with an official Ishihara Test, as this is the most widely used and effective screening test for red-green color deficiency (Birch, 1997). During an Ishihara test, individuals are presented with a series of plates, each containing a circle filled with dots of different colors, brightness, and sizes. Within these dots, a number is presented. An assessment of the readings of plates 1 to 21 determines the normality or defectiveness of color vision. To ensure more certainty, participants were shown all 25 plates. If 17 or more plates are read normally, their color vision is considered normal. If they read only 13 or fewer plates normally, their color vision is regarded as deficient (Ishihara, 1960).

After successfully completing the Ishihara test, participants were presented with the first three questions of the survey where they filled in their demographics, including age, gender, and highest level of completed education. They were then shown one of four stimuli and asked to imagine themselves waiting for a bus in order to establish a realistic setting where they would see this advertisement. This situational prompt was also included in the survey, allowing participants to read it as well. After sketching the imagined scenario, participants continued with the survey. At this point, the stimuli were turned over and set aside until later in the experiment.

In the following part of the survey, participants were asked to answer questions regarding the outcome measures. After addressing the dependent variables, participants were

asked about their sensitivity to design, particularly how advertisements' design makes them feel and shapes their impressions. Finally, information on their eating habits was gathered, providing context for how such products might fit into their diet.

Participants were then given the opportunity to view the advertisement once more. After it was flipped over again, they were asked two more questions on a 7-point likert scale regarding how many different colors they perceived and to what extent they found the colors in the advertisement background to be intense. These questions served as a manipulation check to ensure that participants had noticed a difference between the stimuli.

3.5 Sample

According to the European Institute of Innovation and Technology Food (EIT Food, 2021), 72% of Generation Z prioritize healthy eating for their physical and mental well-being, and 71% aim to eat healthily at home. However, Statistics Netherlands (CBS, 2023) reported that a quarter of individuals aged 18 to 25 are overweight, with 7% classified as severely overweight (obese). Therefore, this study focused on Generation Z, defined as those born between 1995 and 2010. Due to ethical considerations, only individuals aged 18 and over were included.

The study utilized convenience and snowball sampling methods to gather participants from Generation Z, specifically targeting those aged 18 to 30. After conducting the Ishihara test, a total of five individuals answered insufficiently and appeared to have a color vision deficiency. They were excluded from participation. A total of 164 individuals participated in the experiment. Participants outside the age range of 18 to 30 years old were excluded from further analysis. Table 3 shows the sociodemographic data of the remaining 160 participants. The majority of the participants were aged between 23 and 25 (M = 23.9, SD = 3.31). Most participants were male, accounting for 63.1%, while females accounted for 36.2%.

Additionally, there was one participant who identified as ‘other.’ Furthermore, the highest level of education for nearly half of the participants was a bachelor's degree, followed by high school. Only a small percentage of participants had earned a Master's degree, and fewer had completed vocational education.

Table 3

Participant socio-demographic statistics

		n	%
Age			
	18 years	3	1.9%
	19 years	10	6.2%
	20 years	12	7.5%
	21 years	13	8.1%
	22 years	12	7.5%
	23 years	21	13.1%
	24 years	21	13.1%
	25 years	21	13.1%
	26 years	12	7.5%
	27 years	14	8.8%
	28 years	8	5.0%
	29 years	6	3.8%
	30 years	7	4.4%
Gender			
	Male	101	63.1%
	Female	58	36.2%
	Other	1	0.6%
Education			
	High School	52	32.5%
	Vocational education	8	5.0%
	Bachelor's degree	70	43.8%
	Master's degree	30	18.8%

4. Results

4.1 Manipulation check

Although, the amount of hues in the background of the advertisement was pre-tested, it was still decided to check whether participants really saw a difference between the stimuli used in this study. Table 4 shows the results. Comparing the results of the perceived colors, participants indeed saw more colors in the stimuli with five colors (M = 3.29, SD = 1.77), compared to those consisting of two (M = 2.44, SD = 1.46), t(152.27) = –3.31, p = 0.001. The same goes for the saturation. Participants experienced the stimuli with a low saturation as less intense (M = 3.14, SD = 1.76), than the ones with a high saturation (M = 4.25, SD = 1.92), t(156.87) = –3.82, p = 0.000. It can be concluded that participants did see a difference between the stimuli.

Table 4

Manipulation check scores

	n	Mean	SD
Low hue	80	2.44	1.46
High hue	80	3.29	1.77
Low saturation	80	3.14	1.76
High saturation	80	4.25	1.92

4.2 Scale descriptives

Prior to the ANCOVA analysis, the mean scores and standard deviations of all measured scales were calculated. As shown in Table 5, participants reported a moderate perception of naturalness, suggesting that the product was not strongly associated with natural qualities such as being healthy, pure, and fresh after seeing the advertisement. This perception may be influenced by the nature of the product. In the pre-test regarding the type of drink, the disadvantages expressed for protein lemonade by participants were potential

added sugars and possibly unhealthy or processed ingredients. This could be a general belief that protein lemonade is not natural.

Participants rated their attitude toward the product the highest among all scales, suggesting a positive attitude toward the protein lemonade after seeing the advertisements. The feelings evoked while viewing the advertisement were somewhat weaker.

Furthermore, the Aaker (1997) brand personality scale, including the dimensions Sincerity, Excitement, Competence, and Sophistication, received relatively high scores, indicating that participants had positive associations with the protein lemonade's brand. Especially, Competence and Sophistication scored high, reflecting that after seeing the advertisement, participants perceived the brand as reliable, intelligent, and successful, as well as upper-class and charming. In contrast, the fifth dimension, Ruggedness, was rated the lowest of all scales, suggesting that participants did not associate the brand with outdoorsy and toughness.

Lastly, participants were asked about the extent to which they are aware of, influenced by, and appreciative of the aesthetic and stylistic elements in advertisements, and their eating habits. They noted that they were moderately sensitive to designs in advertisements. Additionally, participants reported relatively healthy eating habits. The expected price indicated by participants for the protein lemonade was € 4.54 (*SD* = 3.17).

Table 5

Scale descriptives

	n	Mean	SD
Measurement scales:			
Perception of naturalness [a)]	160	3.69	1.19
Attitude [b)]	160	4.64	1.07
Emotional response (feeling) [c)]	160	3.86	1.16
Sincerity [c)]	160	4.32	1.23
Excitement [c)]	160	4.21	1.08

Table 5 continued

Competence [c)]	160	4.62	1.17
Sophistication [c)]	160	4.48	1.29
Ruggedness [c)]	160	3.56	1.25
Sensitivity to design [d)]	160	3.89	1.29
Eating habits [e)]	160	4.63	0.89

a) 7-point likert scale (1 = Not at all / 7 = Completely so)

b) 7-point bipolar scale ranging from negative to positive

c) 7-point likert scale (1 = Strongly disagree / 7 = Strongly agree)

d) 7-point likert scale (1 = Not at all / 7 = Very much so)

e) 7-point likert scale (1 = Never / 7 = Always)

4.3 The effect of eating habits as a covariate

A 2 (hue diversity: low versus high) × 2 (color saturation: low versus high) × 2 (sensitivity to design: low versus high) factorial ANCOVA was performed to see whether eating habits served as a covariate. The results of the ANCOVA show no significant effect of eating habits on the outcome variables (See Table 6), meaning individuals who consume a healthy diet did not respond more positively to the protein lemonade advertisement than individuals who follow a less healthy diet.

Table 6

F-value and p for eating habits as a covariate on outcome variables

Variables	F-value	p
Perception of Naturalness	1.69	0.195
Attitude	0.01	0.917
Feeling	0.07	0.797
Sincerity	2.35	0.127
Excitement	2.06	0.154
Competence	0.14	0.707
Sophistication	0.75	0.388
Ruggedness	0.24	0.625

4.4 The effect of hue and saturation

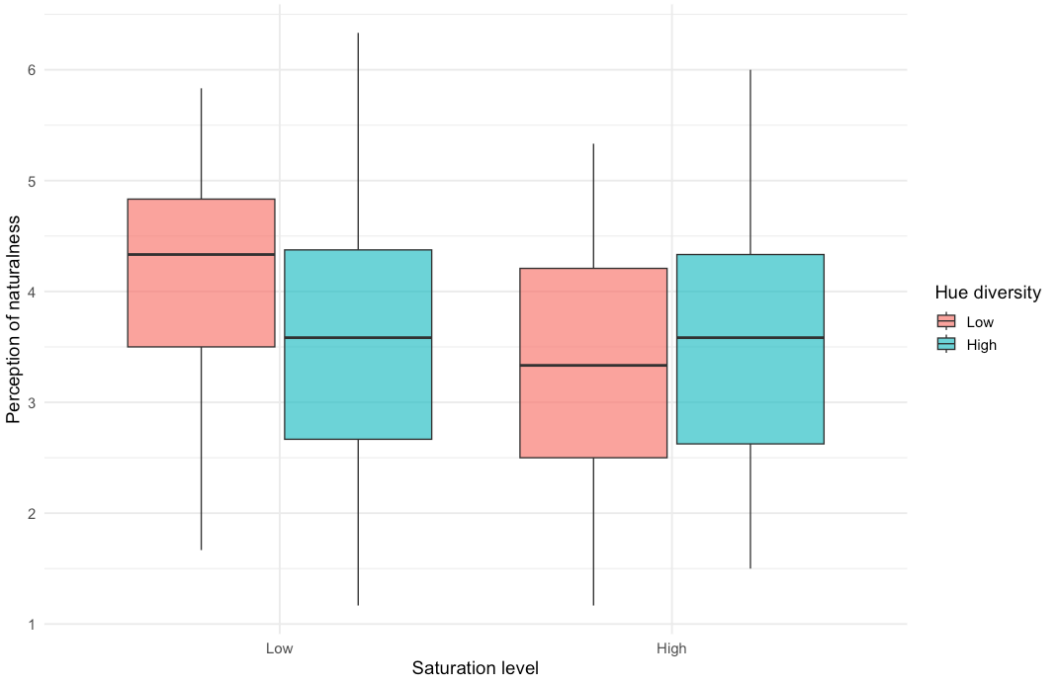
Although eating habits were not a significant covariate, they were conceptually expected to influence the outcome variables. Therefore, it was decided to still perform a 2 (hue diversity: low versus high) × 2 (color saturation: low versus high) × 2 (sensitivity to design: low versus high) factorial ANCOVA to see if there was a significant effect between hue (low vs. high), saturation (low vs. high), sensitivity to design (moderator), and the outcome variables, with eating habits included as a covariate. Please refer to Appendix F for the full ANCOVA table.

4.4.1 Perception of naturalness

The results revealed there was a significant main effect of hue diversity on perception of naturalness ($F = 4.09$, $p = 0.045$), as well as saturation on perception of naturalness ($F = 6.02$, $p = 0.015$). Figure 5 illustrates the main effect, confirming that both low (vs. high) hue diversity and low (vs. high) saturation levels positively affect perception of naturalness, and thereby supporting H1 and H2. Lastly, there were no significant interaction effects between hue diversity and saturation level on perception of naturalness.

Figure 5

Main effect hue diversity and saturation level on perception of naturalness



4.4.2 Attitude

There were no significant main effects found for hue diversity ($F = 1.05$, $p = 0.307$) or saturation levels ($F = 2.42$, $p = 0.122$) on attitude, suggesting that variations in hue diversity and saturation levels did not influence consumers' attitudes. In addition, there were no interaction effects between hue diversity and saturation level on attitude.

4.4.3 Emotional response (feeling)

There were no significant main effects for hue diversity ($F = 1.36$, $p = 0.246$). However, saturation levels ($F = 3.74$, $p = 0.055$) showed a marginally significant effect on emotional response, providing no support for H3 and approaching support for H4. Furthermore, no interaction effects observed between hue diversity and saturation level in relation to emotional response (feeling).

4.4.4 Brand impressions

The brand personality scale dimensions showed varying results. For hue diversity, there were no significant main effects observed on Sincerity ($F = 3.65$, $p = 0.058$), Excitement ($F = 0.35$, $p = 0.557$), Competence ($F = 0.10$, $p = 0.306$), and Sophistication ($F = 0.02$, $p = 0.882$). In contrast, the ANCOVA showed a significant main effect for hue diversity on Ruggedness ($F = 4.86$, $p = 0.029$). The analysis revealed that a low (vs. high) hue positively affected Ruggedness (See figure 6). Further analysis revealed an interaction effect observed with hue diversity × sensitivity to design ($F = 5.03$, $p = 0.026$). For individuals with a low design sensitivity, low (vs. high) hue diversity had a positive effect on Ruggedness. However, for individuals with a high sensitivity to design, a high (vs. low) hue positively affects Ruggedness (See Figure 7).

Figure 6

Main effect hue diversity and saturation level on Ruggedness

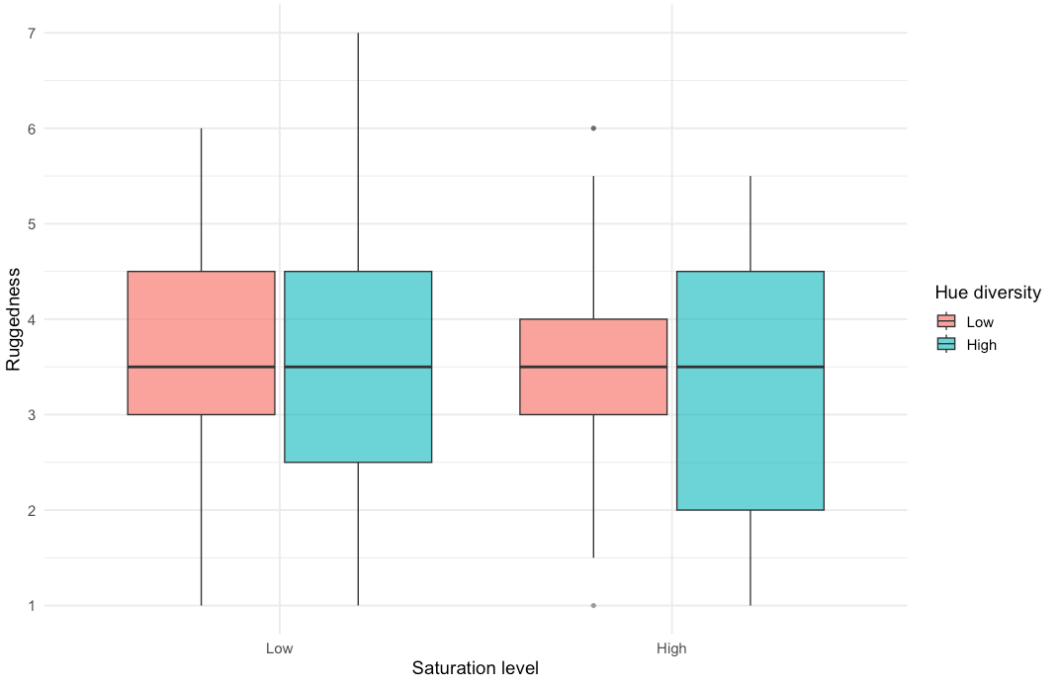
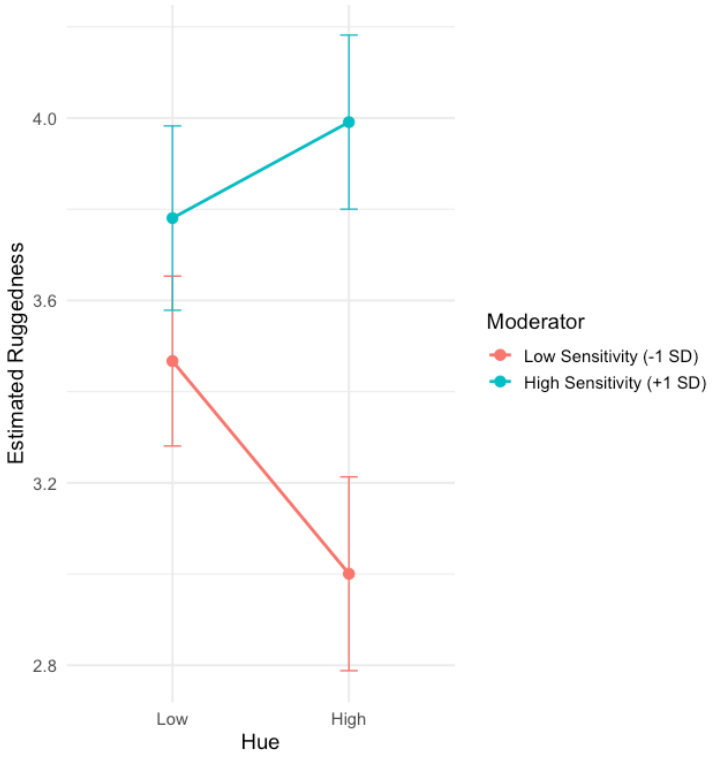


Figure 7

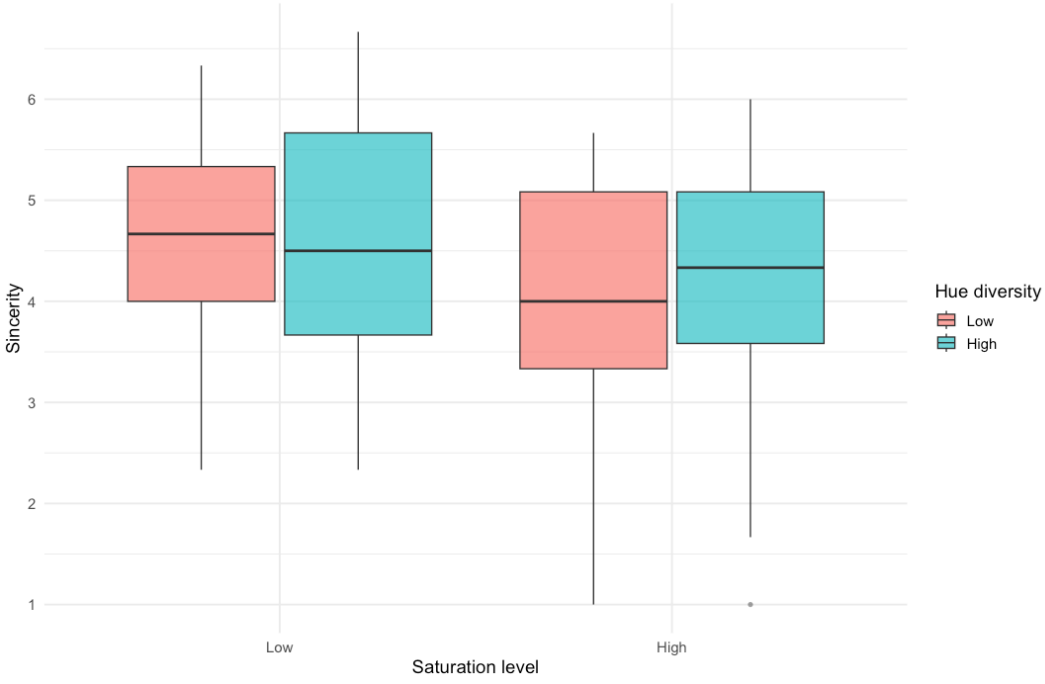
Hue × sensitivity to design interaction effect plot for Ruggedness



For saturation, no significant main effects were observed for Excitement (F = 2.84, p = 0.557), Competence (F = 0.48, p = 0.489), Sophistication (F = 0.19, p = 0.668), and Ruggedness (F = 0.31, p = 0.581), while Sincerity (F = 5.03, p = 0.026) was significant. Figure 8 shows that high (vs. low) saturation levels negatively affect Sincerity. Finally, there were no interaction effects between hue diversity and saturation level on Sincerity, Excitement, Competence, Sophistication, and Ruggedness.

Figure 8

Main effect hue diversity and saturation level on Sincerity



4.4.5 Price expectancy

Lastly, no significant main effects were observed of hue diversity (F = 0.382, p = 0.368) or saturation levels (F = 0.09, p = 0.760) on price expectancy. Although no significant relationships were found, Table 7 illustrates the price expectancy for each stimulus.

Table 7

Price expectancy per stimulus

	Mean	SD
Low hue × Low saturation	2.75	1.53
Low hue × High saturation	3.95	1.99
High hue × Low saturation	3.52	1.91
High hue × High saturation	4.55	1.83

4.4 The effect of sensitivity to design as a moderator

The study examined whether sensitivity to design moderates the effect of hue and saturation on the outcome variables. The three-way ANCOVA revealed no significant interaction effects between hue diversity or saturation level and sensitivity to design on all outcome variables (see Table 8), except for the interaction between hue diversity and sensitivity to design on Ruggedness ($F = 5.03$, $p = 0.026$). This suggests that sensitivity to design only has moderating effect on Ruggedness.

Table 8

F-value and p for sensitivity to design as a moderator on outcome variables

Variables		F-value	p
Perception of Naturalness			
	Hue × sensitivity to design	1.91	0.226
	Saturation × sensitivity to design	2.29	0.164
	Hue × saturation × sensivity to design	0.70	0.144
Attitude			
	Hue × sensitivity to design	0.81	0.369
	Saturation × sensitivity to design	0.73	0.396
	Hue × saturation × sensivity to design	1.20	0.274
Emotional response (feeling)			
	Hue × sensitivity to design	1.48	0.226
	Saturation × sensitivity to design	1.95	0.164
	Hue × saturation × sensivity to design	2.16	0.144
Sincerity			
	Hue × sensitivity to design	3.87	0.510
	Saturation × sensitivity to design	2.25	0.136

Table 8 continued

	Hue × saturation × sensivity to design	2.39	0.125
Excitement			
	Hue × sensitivity to design	0.49	0.484
	Saturation × sensitivity to design	1.29	0.258
	Hue × saturation × sensivity to design	1.66	0.199
Competence			
	Hue × sensitivity to design	0.02	0.894
	Saturation × sensitivity to design	2.26	0.134
	Hue × saturation × sensivity to design	4.90E-08	1
Sophistication			
	Hue × sensitivity to design	0.08	0.777
	Saturation × sensitivity to design	0.03	0.855
	Hue × saturation × sensivity to design	0.03	0.873
Ruggedness			
	Hue × sensitivity to design	5.03	0.026*
	Saturation × sensitivity to design	0.18	0.669
	Hue × saturation × sensivity to design	2.02	0.158

4.8 Summary of the results

Table 1

Overview of hypotheses and research questions results

Hypotheses / Research questions		Result
H1	Low (vs. high) hue diversity in food advertisements positively affects perception of naturalness.	Confirmed
H2	Low (vs. high) saturation levels in food advertisements positively affect perception of naturalness.	Confirmed
H3	High (vs. low) hue diversity in food advertisements positively affects emotional response, reflected in feeling, towards the product.	Not supported
H4	High (vs. low) saturation levels in food advertisements positively affect emotional response, reflected in feeling, towards the product.	Not supported
H5	High (vs. low) hue diversity in food advertisements positively affects attitude towards the product.	Not supported
H6	High (vs. low) saturation levels in food advertisements positively affect attitude towards the product.	Not supported
H7	The effects of hue diversity and saturation in healthy food advertisements on perceived naturalness, emotional response, attitude, and brand impressions will be stronger for consumers with high sensitivity to design, compared to those with low sensitivity to design.	Not supported
H8	Individuals who consume a healthy diet may respond more positively to advertisements for healthy products than people who follow a less healthy diet.	Not supported
RQ1	How do hue diversity and saturation levels affect perceptions of brand personality dimensions?	Low (vs. high) hue diversity had a positive effect on Ruggedness, High (vs. low) saturation level had negative effect on Sincerity
RQ2	How do hue diversity and saturation levels in healthy food advertisements affect consumers' price expectancy?	No effect of hue diversity and saturation level on price expectancy
RQ3	How do hue diversity and saturation level interact, alongside sensitivity to design and eating habits, to shape perceptions of naturalness, emotional response, attitude, and brand impressions?	Interaction between hue diversity × sensitivity to design for Ruggedness (brand impressions)

5. Discussion

5.1 Main findings

This study explored how variations in hue diversity and saturation level of colors used in healthy food advertisements influence consumer perceptions of naturalness, their emotional responses, attitudes, and brand impressions. The 2 (hue diversity: low versus high) × 2 (color saturation: low versus high) × 2 (sensitivity to design: low versus high) between-subjects design revealed that low variations in hue diversity and saturation level positively affect perception of naturalness. These results are consistent with Berman et al. (2014), who discovered that variations in hue, particularly lower hue diversity, significantly enhance perceptions of naturalness, and Huang (2021), who argued that consumers are more likely to perceive low-saturated colors as more natural. An explanation for this can be that a low hue diversity comes across as more uniform and harmonious and therefore perceived as more natural (Berman et al., 2014). A high saturation level can be perceived as artificial and therefore not look natural.

The predicted effects of hue diversity and saturation level on attitude and emotional response were surprisingly not revealed in the results of this study. One possible explanation for this result is that perceived naturalness may act as a mediating factor, such that color influences attitude and emotion indirectly through perceptions of naturalness.

The effects of hue and saturation on brand impressions show different results. Despite previous studies stating that highly saturated colors evoke feelings of dynamism, liveliness, and consistently convey a more vivid and intense brand imagery, enhancing Excitement, Competence and Ruggedness (Kawamata & Moriguchi, 2024; Labrecque & Milne, 2012), this study found that for healthy food advertisements, that was not the case, indicating that the influence of high saturation levels on brand impressions like Excitement, Competence and Ruggedness might depend on the product context. A low saturation level, however, was

associated with Sincerity, suggesting that visual simplicity may communicate trustworthiness. Furthermore, this study found that a low hue diversity positively affected Ruggedness, contrary to previous literature, which suggested that higher hue diversity might provide a more dynamic and engaging visual experience, potentially enhancing perceptions of Ruggedness (Kim & Sung, 2010; Labrecque & Milne, 2012). However, the effect of hue diversity on Ruggedness was influenced by sensitivity to design, showing an interaction effect between these two variables. For individuals with low design sensitivity, low hue diversity positively affected perceptions of Ruggedness. Conversely, for individuals with high design sensitivity, high hue diversity had a positive effect on Ruggedness. Therefore, the effect of hue on Ruggedness might depend on the consumers' sensitivity to design. One possible explanation for this interaction is that individuals with low sensitivity to design may perceive a lower amount of hue as simple, sturdier, and more solid, aligning with their view of Ruggedness as strength and durability. In contrast, individuals with high design sensitivity may interpret Ruggedness as adventurous, tough, and dynamic, perceiving greater hue diversity as a more vivid and complex representation of this trait. It should be noted that results involving Ruggedness should be interpreted with caution due to a low reliability alpha.

This study also questioned what the effects of hue diversity and saturation level were on price expectancy. There were no direct main effects observed. Prior literature suggests that foods perceived as natural are generally considered healthier (Roman et al., 2017), and consumers often believe healthier foods are more expensive (Haws et al., 2017; Jo & Lusk, 2018; Bower et al., 2003). Based on this, one might expect that advertisements that are considered more natural would lead consumers to expect a higher price for the protein lemonade shown in the advertisements. Interestingly, the opposite was observed: the stimuli that were perceived as more natural were associated with a lower price. These findings

challenge the healthy = expensive belief from prior literature (Haws et al, 2017; Jo & Lusk, 2018), which may suggest that perception of naturalness, when cued through visual simplicity (low hue, low saturation), signals authenticity and accessibility rather than exclusivity.

Finally, there was no evidence found for eating habits as a covariate. The findings suggest that consumers' perceptions do not depend on what kind of diet individuals follow. This finding aligns with research showing that food evaluations are often driven by beliefs rather than actual eating patterns. According to Raghunathan et al. (2006), when an item is perceived as less healthy, people tend to believe it tastes better, enjoy it more during consumption, and prefer it more in choice tasks when a hedonic goal is more (vs. less) important. Therefore, self-reported eating habits might not capture factors that influence how people process health-related advertising. Instead, eating habits may play a greater role in behavioral outcomes, such as purchase or consumption intentions, rather than in perceptual or emotional responses to visual cues.

5.2 Theoretical implications

Despite the growing body of research on color psychology and its impact on consumer behavior, the relationship between color and the perception of naturalness in the context of healthy food advertisements remains largely unexplored. This study contributes to the literature on color psychology in advertising by showing the important role that perception of naturalness plays. Naturalness is a key characteristic in food evaluation. Binninger (2015) mentioned that the perceived naturalness of a product positively correlates with its attractiveness, quality, credibility, and intent to purchase. Previous findings emphasized the relationship between naturalness and healthiness (Roman et al., 2017; Hagen, 2020). As previously mentioned, this study did not reveal any significant effects of hue diversity and saturation level on attitude or emotional response. Arguably, hue diversity and

saturation levels may influence consumer evaluations indirectly through the mediation of perception of naturalness.

Additionally, while many studies have examined how color affects consumer behavior, they tend to focus mainly on individual colors rather than combinations (Labrecque, 2020). By exploring variations in hue diversity and focusing on more complex color combinations, this study addresses the gap in research on colors in marketing, recognizing that consumers rarely encounter single-color stimuli in advertising.

5.3 Practical implications

The findings of this study provide valuable information on how marketers can use color in their advertising to create effective strategies to promote healthy foods. The results show that the use of a low hue diversity and low saturation increases perception of naturalness. When a product is perceived as more natural by consumers, it is also considered healthier (Roman et al., 2017; Hagen, 2020). Therefore, it is important for marketers to be selective in the amount and intensity of colors they use for their advertisements, in order to enhance consumers' evaluation.

Furthermore, by carefully selecting colors that align with the desired traits of a brand, marketers can effectively communicate the brand's personality to consumers. Research shows that consumers are more attracted to highly saturated colors (Huang et al., 2013). However, while these colors may be visually appealing, this study shows that the use of highly saturated colors can hurt a brand's sincerity. Therefore, if marketers want to convey a brand as trustworthy and sincere, they could consider to use low saturaed colors.

Marketers can use this information to create effective advertising strategies to promote healthy foods, which may ultimately help mitigate the global health crisis of overweight and obesity.

5.4 Limitations and future research

Despite its theoretical and practical contributions, there are limitations to this study. First, although the manipulation check was sufficient and participants did see a difference between the stimuli, they found it hard to determine how many colors they saw or how intense they were when they did not see the stimuli anymore. Bae et al. (2015) suggest that while individuals can perceive many shades of color, when stimuli disappear and individuals rely on memory, they tend to remember colors as one of a few "basic hues" rather than the precise shade they actually saw due to categorical bias. This could affect the manipulation check. Nonetheless, even when participants reported seeing something different from the actual stimuli, they did notice a difference when shown the stimuli again. Additionally, participants were asked to rate the number of hues and the intensity of colors on a 7-point Likert scale. Some participants expressed confusion about the definitions of few and many, as well as their interpretations of not intense versus intense. Future studies could employ different scales for measurement. For example, they could assess the number of colors based on the actual colors presented in the stimuli or use a zero to ten scale to rate intensity.

Another limitation within this study is the print quality of the stimuli. The study recognized the print quality as a possible issue and, therefore, decided to print the stimuli professionally. However, some colors were harder to see on the printed stimuli than they were digitally. On a screen, it was easier to distinguish certain colors, especially with stimuli consisting of five hues. Therefore, while the stimuli were printed professionally, this aspect still represents a limitation.

Furthermore, the reliability issues of Ruggedness and Sophistication were a problem, especially because there was an interaction effect observed between hue diversity and sensitivity to design on Ruggedness. As a result, the findings associated with these dimensions need to be interpreted with caution. Future studies may consider using Aaker's

(1997) full 42-item scale to measure brand impressions, instead of the framework, where Sophistication and Ruggedness only have two items. This approach could help resolve the reliability issues.

In addition to its limitations, this study also opens the door for future research. A promising direction is to explore the role of perceived naturalness as a mediator between hue diversity and saturation levels in relation to other outcome variables. The findings revealed that hue diversity and saturation level significantly influenced perceived naturalness, whereas their effects on attitude and emotional response were not significant. It could be argued that perception of naturalness might have an influence on attitude and emotional response. For instance, when consumers perceive a product as more natural, their overall attitude toward the product may become more positive. Prior research already indicates that perceived naturalness positively influences purchase intention (Binninger, 2015; Zhang et al., 2024). So, it could be that perceived naturalness serves as a bridge between visual cues, such as hue and saturation, and consumer evaluations of healthy food advertisements.

Future studies could further investigate this relationship between hue diversity and saturation level on attitude and emotional response with perception of naturalness as a mediator to better understand how visual cues in healthy food advertisements shape consumer evaluations and affective responses.

Finally, the surprising result that stimuli with an enhanced perception of naturalness were associated with a lower price expectancy raises several questions. While it was anticipated that healthier food would be associated with higher price expectations, these findings suggest otherwise. Future research could analyze how the perception of naturalness influences consumers' price expectations in advertising, and whether the healthy = expensive belief still exists. Additionally, future research could also examine the impact of price

revelation. For instance, if a healthy product is expected to be inexpensive is actually offered at a low price, does this reduce perceived quality or trustworthiness among consumers?

5.5 Conclusion

This study explored how variations in hue diversity and saturation levels of colors used in healthy food advertisements influence consumers' perceptions of naturalness, emotional response, attitude, and brand impressions. The findings show that low hue diversity and saturation level significantly enhances consumers' perception of naturalness. Additionally, the study shows that the use of low saturated colors can make a brand appear more sincere. In contrast, design sensitivity had no direct effect, but appeared only to be significant in an interaction effect with hue diversity on Ruggedness. The effect of hue diversity on Ruggedness might depend on the consumers' sensitivity to design.

In conclusion, color plays a central role in determining perception of naturalness. Marketers can use this valuable knowledge to create advertising strategies to promote healthy foods in order to try to reduce the global health crisis of overweight and obesity. Theoretically, this study provides a foundation for future research exploring how visual cues such as hue diversity and saturation level in healthy food advertisements shape consumer evaluations and affective responses. Overall, this study underscores the power of color as a subtle yet influential communication tool in healthy food advertising, deepening the understanding of how visual design shapes consumer perception and evaluations.

AI Statement

During the preparation of this work, the author used Grammarly, Quillbot and ChatGPT to improve the quality of the written text. Grammarly helps with writing and provides suggestions on fluency, grammar, punctuation, and spelling, while QuillBot is a paraphrasing tool designed to help users improve their writing. ChatGPT is an OpenAI chatbot which is used for inspiration, sentence structure and improvement and checking the clarity of paragraphs. After using these tools, the author reviewed and edited the content as needed and took full responsibility for the content of the work.

References

Aaker, J. L. (1997). Dimensions of brand personality. *Journal of marketing research, 34*(3), 347-356. https://doi.org/10.1177/002224379703400304

Afshin, A., Sur, P. J., Fay, K. A., Cornaby, L., Ferrara, G., Salama, J. S., Mullany, E. C., Abate, K. H., Abbafati, C., Abebe, Z., Afarideh, M., Aggarwal, A., Agrawal, S., Akinyemiju, T., Alahdab, F., Bacha, U., Bachman, V. F., Badali, H., Badawi, A., & Bensenor, I. M. (2019). Health effects of dietary risks in 195 countries, 1990–2017: a systematic analysis for the global burden of disease study 2017. *The Lancet, 393*(10184), 1958–1972. https://doi.org/10.1016/S0140-6736(19)30041-8

Altmann, B. A., Trinks, A., & Mörlein, D. (2023). Consumer preferences for the color of unprocessed animal foods. *Journal of Food Science, 88*(3), 909–925. https://doi.org/10.1111/1750-3841.16485

Azoulay, A., & Kapferer, J. N. (2003). Do brand personality scales really measure brand personality? *Journal of brand management, 11*, 143-155. https://doi.org/10.1057/palgrave.bm.2540162

Babin, L. A., & Burns, A. C. (1997). Effects of print ad pictures and copy containing instructions to imagine on mental imagery that mediates attitudes. *Journal of advertising, 26*(3), 33-44. https://doi.org/10.1080/00913367.1997.10673527

Bae, G. Y., Olkkonen, M., Allred, S. R., & Flombaum, J. I. (2015). Why some colors appear more memorable than others: A model combining categories and particulars in color working memory. *Journal of Experimental Psychology: General, 144*(4), 744. http://doi.org/10.1037/xge0000076

Bagchi, R., & Cheema, A. (2013). The effect of red background color on willingness-to-pay: the moderating role of selling mechanism. Journal of Consumer Research, 39(5), 947-960. https://doi.org/10.1086/666466

Baker, M. J., & Churchill, G. A. (1977). The impact of physically attractive models on advertising evaluations. *Journal of Marketing Research, 14*(4), 538–555. https://doi.org/10.2307/3151194

Batra, R., & Ray, M. L. (1986). Affective responses mediating acceptance of advertising. *Journal of consumer research, 13*(2), 234-249. https://www.jstor.org/stable/2489229

Becker, L., van Rompay, T. J., Schifferstein, H. N., & Galetzka, M. (2011). Tough package, strong taste: The influence of packaging design on taste impressions and product evaluations. *Food quality and preference, 22*(1), 17-23. https://doi.org/10.1016/j.foodqual.2010.06.007

Berman, M. G., Hout, M. C., Kardan, O., Hunter, M. R., Yourganov, G., Henderson, J. M., ... & Jonides, J. (2014). The perception of naturalness correlates with low-level visual features of environmental scenes. *PloS one, 9*(12), e114572. https://doi.org/10.1371/journal.pone.0114572

Bezjian-Avery, A., Calder, B., & Iacobucci, D. (1998). New media interactive advertising vs. traditional advertising. *Journal of advertising research, 38*, 23-32.

https://people.utm.my/thoo/wp-content/blogs.dir/1795/files/2016/03/New-Media-Interactive-Advertising-Vs-Traditional-Advertising.pdf

Bielaszka, A., Staśkiewicz-Bartecka, W., Kiciak, A., Wieczorek, M., & Kardas, M. (2024). Color and its effect on dietitians' food choices: Insights from tomato juice evaluation. *Beverages, 10*(3), 70. https://doi.org/10.3390/beverages10030070

Binninger, A. (2015). Perception of naturalness of food packaging and its role in consumer Product Evaluation. *Journal of Food Products Marketing, 23*(3), 251–266. https://doi.org/10.1080/10454446.2014.885868

Birch, J. (1997). Efficiency of the Ishihara test for identifying red-green colour deficiency. Ophthalmic and Physiological Optics, 17(5), 403-408. https://doi.org/10.1016/S0275-5408(97)00022-7

Bloch, P. H., Brunel, F. F., & Arnold, T. J. (2003). Individual differences in the centrality of visual product aesthetics: Concept and measurement. *Journal of consumer research, 29*(4), 551-565. https://doi.org/10.1086/346250

Bolarić, M., & Šatalić, Z. (2013). The relation between food price, energy density and diet quality. *Croatian journal of food science and technology, 5*(2), 39-45. https://hrcak.srce.hr/file/168067

Bornhofen, C., & Mcdonald, S. (2008). Emotion perception deficits following traumatic brain injury: A review of the evidence and rationale for intervention. *Journal of the International Neuropsychological Society, 14*(4), 511-525. https://doi.org/10.1017/S1355617708080703

Bortolotti, A., Cannito, L., Anzani, S., & Palumbo, R. (2023). The promise of color in marketing: use, applications, tips and neuromarketing. *Cultura e Scienza del Colore-Color Culture and Science*, *15*(01), 76-85. https://doi.org/10.23738/CCSJ.150110

Bower, J. A., Saadat, M. A., & Whitten, C. (2003). Effect of liking, information and consumer characteristics on purchase intention and willingness to pay more for a fat spread with a proven health benefit. *Food Quality and Preference, 14*(1), 65-74. https://doi.org/10.1016/S0950-3293(02)00019-8

Bytyçi, S. (2020). Influence of colors as a key element in consumer marketing. *Expert journal of marketing, 8*(1), 41-47. https://marketing.expertjournals.com/ark:/16759/EJM_803bytyçi41-47.pdf.

Cakmak, M. C., Shaik, M., & Agarwal, N. (2024). Emotion assessment of YouTube videos using color theory. In Proceedings of the 2024 9th International Conference on Multimedia and Image Processing (pp. 6-14). https://doi.org/10.1145/3665026.3665028

Chen, Y., Yang, J., Pan, Q., Vazirian, M., & Westland, S. (2020). A method for exploring word-colour associations. *Color Research & Application, 45*(1), 85-94. https://doi.org/10.1002/col.22434

Daniel, C. (2020). Is healthy eating too expensive?: How low-income parents evaluate the cost of food. *Social Science & Medicine, 248*, 112823. https://doi.org/10.1016/j.socscimed.2020.112823

Dantec, M., Allain, H., Yvert, N., Sigrist, J., Bensafi, M., & Lafraire, J. (2022). Olfactory attributes and colors associated with naturalness. Food Quality and Preference, 98, 104495. https://doi.org/10.1016/j.foodqual.2021.104495

De Bortoli, M., & Maroto, J. (2001). Colours across cultures: Translating colours in interactive marketing communications. *European Languages and the Implementation of Communication and Information Technologies*, 1-27. https://www.globalpropaganda.fresa.net/articles/TranslatingColours.pdf

Denniss, E., Lindberg, R., & McNaughton, S. A. (2023). Nutrition-related information on Instagram: A content analysis of posts by popular Australian accounts. *Nutrients, 15*(10), 2332.

Edell, J. A., & Burke, M. C. (1987). The power of feelings in understanding advertising effects. *Journal of Consumer research*, 421-433. https://www.jstor.org/stable/2489502

Eisinga, R., Grotenhuis, M. T., & Pelzer, B. (2013). The reliability of a two-item scale: Pearson, Cronbach, or Spearman-Brown?. *International journal of public health, 58*(4), 637-642. https://doi.org/10.1007/s00038-012-0416-3

Elliot, A. J., & Maier, M. A. (2014). Color psychology: Effects of perceiving color on psychological functioning in humans. *Annual review of psychology*, *65*(1), 95-120. https://doi.org/10.1146/annurev-psych-010213-115035

European Institute of Innovation and Technology Food. (2021). Our food, our food system: What generation z wants from a healthy food system. *EIT Food.* https://www.eitfood.eu/media/news-pdf/Our_Food%2C_Our_Food_System_-_EIT_Food_report_.pdf

Hagen, L. (2020). Pretty healthy food: how and when aesthetics enhance perceived healthiness. *Journal of Marketing, 85*(2), 129–145. https://doi.org/10.1177/0022242920944384

Haws, K. L., Reczek, R. W., & Sample, K. L. (2017). Healthy diets make empty wallets: The healthy = expensive intuition. *Journal of Consumer Research, 43*(6), 992-1007. https://doi.org/10.1093/jcr/ucw078

Heywood, C. A., Kentridge, R. W., & Cowey, A. (1998). Cortical color blindness is not "blindsight for color." *Consciousness and Cognition, 7*(3), 410–423. https://doi.org/10.1006/ccog.1998.0364

Huang, J., Fei, X., & Jiang, Y. (2023). I want to remember: Preference for visual intensity in sentimental purchases. *Psychology & Marketing, 40*(7), 1361–1371. https://doi.org/10.1002/mar.21819

Huang, Y., Yang, L., & Liu, M. (2021). How to display products available in multiple color saturation: Fit between saturation and position. *Psychology & Marketing, 39*(4), 809–819. https://doi.org/10.1002/mar.21622

Ishihara, S. (1960). *Tests for colour-blindness* (15th ed.). Kanehara Shuppan, Co., Ltd.

Ismail, L. C., Osaili, T. M., Obaid, R. S., Hashim, M., Ahmed, M., Fatma Al-Fayadh, Farah, A., Sad, H., Humood Alghanem, Mohamad, M. N., Saleh, S. T., Rameez Al Daour, Emad Masuadi, Stojanovska, L., Ali, H. I., & Al, A. S. (2025). Food choice motivations and perceptions of healthy eating: a cross-sectional study among consumers in the UAE. *BMC Public Health, 25*(1). https://doi.org/10.1186/s12889-024-20836-8

Jo, J., & Lusk, J. L. (2018). If it's healthy, it's tasty and expensive: Effects of nutritional labels on price and taste expectations. *Food Quality and Preference, 68*, 332-341. https://doi.org/10.1016/j.foodqual.2018.04.002

Jonauskaite, D., Abu-Akel, A., Dael, N., Oberfeld, D., Abdel-Khalek, A. M., Al-Rasheed, A. S., Antonietti, J.-P., Bogushevskaya, V., Chamseddine, A., Chkonia, E., Corona, V., Fonseca-Pedrero, E., Griber, Y. A., Grimshaw, G., Hasan, A. A., Havelka, J., Hirnstein, M., Karlsson, B. S. A., Laurent, E., & Lindeman, M. (2020). Universal Patterns in Color-Emotion Associations Are Further Shaped by Linguistic and Geographic Proximity. *Psychological Science, 31*(10), 1245–1260. https://doi.org/10.1177/0956797620948810

Kale, S. (2021, September 15). Muscles and methane: how protein became the food industry's biggest craze. *The Guardian*.

https://www.theguardian.com/food/2021/sep/15/muscles-and-methane-how-protein-became-the-food-industrys-biggest-craze

Kawamata, H., & Moriguchi, T. (2024). The Effect of Color Saturation on Brand Attitudes in Brand Logo Redesign. *Quarterly Journal of Marketing, 44*(2), 158-166. https://doi.org/10.7222/marketing.2024.047

Kellaris, J. J., Cox, A. D., & Cox, D. (1993). The effect of background music on ad processing: A contingency explanation. *Journal of Marketing, 57*(4), 114-125. https://doi.org/10.1177/0022242993057004

Kellaris, J. J., Cox, A. D., & Cox, D. (1993). The effect of background music on ad processing: A contingency explanation. *Journal of Marketing, 57*(4), 114-125. https://doi.org/10.1177/002224299305700409

Keller, K. L. (1991). Cue compatibility and framing in advertising. *Journal of Marketing Research, 28*(1), 42-57. https://doi.org/10.1177/002224379102800104

Keller, K. L., & Lehmann, D. R. (2006). Brands and branding: Research findings and future priorities. *Marketing science, 25*(6), 740-759. https://www.jstor.org/stable/40057218

Kim, S., & Sung, Y. (2010). *The effects of colors on brand personality in advertising* (Doctoral dissertation, University of Texas at Austin). https://doi.org/10.14377/JAPR.2013.9.30.85

Labrecque, L. I. (2020). Color research in marketing: Theoretical and technical considerations for conducting rigorous and impactful color research. *Psychology & Marketing, 37*(7), 855-863. https://doi.org/10.1002/mar.21359

Labrecque, L. I., & Milne, G. R. (2012). Exciting red and competent blue: the importance of color in marketing. *Journal of the Academy of Marketing Science, 40*(5), 711-727. https://doi.org/10.1007/s11747-010-0245-y

Liu, S. Q., Wu, L. L., Yu, X., & Huang, H. (2022). Marketing online food images via color saturation: A sensory imagery perspective. *Journal of Business Research, 151*, 366-378. https://doi.org/10.1016/j.jbusres.2022.06.061

Modi, P., Jha, K., Kumar, Y., Kumar, T., Singh, R., & Mishra, A. (2019). The effect of short-term exposure to red and blue light on the autonomic tone of the individuals with newly diagnosed essential hypertension. *Journal of family medicine and primary care, 8*(1), 14-21. https://doi.org/10.4103/jfmpc.jfmpc_375_18

Nakano, L., Takeuchi, T., Motoyoshi, I., Li, Y., Adelson, E., & Nishida, S. (2009). The effect of color saturation and luminance contrast on color naturalness. *Journal of Vision, 9*(8), 1040. https://doi.org/10.1167/9.8.1040

National Institute of Diabetes and Digestive and Kidney Diseases. (n.d.). Health risks of overweight & obesity. *NIDDK*. https://www.niddk.nih.gov/health-information/weight-management/adult-overweight-obesity/health-risks

Paakki, M., Sandell, M., & Hopia, A. (2019). Visual attractiveness depends on colorfulness and color contrasts in mixed salads. *Food Quality and Preference, 76*, 81-90. https://doi.org/10.1016/j.foodqual.2019.04.004

Pater, L., Zandstra, E. H., Fogliano, V., & Steenbekkers, B. (2025). “What's for Dinner?” Understanding Family Food Decision-Making and Wishes of Children and Their Caregivers for Plant-Based Alternatives in Family Meals. *Appetite, 209*, 107970 https://doi.org/10.1016/j.appet.2025.107970

Pathare, P. B., Opara, U. L., & Al-Said, F. A. J. (2013). Colour measurement and analysis in fresh and processed foods: A review. *Food and bioprocess technology, 6*, 36-60. https://doi.org/10.1007/s11947-012-0867-9

Pridmore, R. W. (2021). Complementary colors: A literature review. *Color Research & Application, 46*(2), 482-488. https://doi.org/10.1002/col.22576

Raghunathan, R., Naylor, R. W., & Hoyer, W. D. (2006). The unhealthy= tasty intuition and its effects on taste inferences, enjoyment, and choice of food products. *Journal of Marketing, 70*(4), 170-184. https://doi.org/10.1509/jmkg.70.4.170

Roman, S., Sánchez-Siles, L. M., & Siegrist, M. (2017). The importance of food naturalness for consumers: Results of a systematic review. *Trends in food science & technology, 67*, 44-57. https://doi.org/10.1016/j.tifs.2017.06.010

Scheres, P. (2024, July 17). Van skyr tot proteïnepoeders: eiwitrijk eten wint aan populariteit. *RTL Nieuws*. https://www.rtl.nl/nieuws/economie/artikel/5460169/van-skyr-tot-proteinepoeders-eiwitrijk-eten-wint-aan-populariteit

Shabgou, M., & Daryani, S. M. (2014). Towards the sensory marketing: stimulating the five senses (sight, hearing, smell, touch and taste) and its impact on consumer behavior. *Indian Journal of Fundamental and Applied Life Sciences*, *4*(1), 573-581. https://www.cibtech.org/sp.ed/jls/2014/01/00(68).pdf

Shagyrov, M., & Shamoi, P. (2024, November). Color and sentiment: a study of emotion-based color palettes in marketing. In *2024 Joint 13th International Conference on Soft Computing and Intelligent Systems and 25th International Symposium on Advanced Intelligent Systems (SCIS&ISIS)* (pp. 1-7). *IEEE*. https://doi.org/10.1109/scisisis61014.2024.10759889

Sheng, Y. (2024, November). The use of fun and humour in the visual identity of Korean fried chicken brands: Strategies based on emotional design theory. In *International Conference on Design and Digital Communication* (pp. 770-783). Cham: Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-77566-6_56

Singh, N., & Srivastava, S. K. (2011). Impact of colors on the psychology of marketing—A Comprehensive over view. *Management and Labour Studies*, *36*(2), 199-209. https://doi.org/10.1177/0258042X1103600206

Singh, S. (2006). Impact of color on marketing. *Management decision, 44*(6), 783-789. https://doi.org/10.1108/00251740610673332

Singh, S. N., Lessig, V. P., Kim, D., Gupta, R., & Hocutt, M. A. (2000). Does your ad have too many pictures? *Journal of Advertising Research, 40*(1-2), 1-19. https://doi.org/10.2501/jar-40-1-2-11-27

Song, L., Zhang, G., Ma, L., Silvennoinen, J., & Cong, F. (2025). Comparative analysis of color emotional perception in art and non-art university students: hue, saturation, and brightness effects in the Munsell color system. *BMC psychology, 13*(1), 650. https://doi.org/10.1186/s40359-025-03034-y

Soti, R. (2022). The impact of advertising on consumer behavior. *World Journal of Advanced Research and Reviews, 14*(3), 706-711. https://doi.org/10.30574/wjarr.2022.14.3.0577

Spence, C. (2015). On the psychological impact of food colour. *Flavour, 4*, 1-16. https://doi.org/10.1186/s13411-015-0031-3

Statistics Netherlands. (2023, June 1). Kwart 18- tot 25-jarigen te zwaar. https://www.cbs.nl/nl-nl/nieuws/2023/22/kwart-18-tot-25-jarigen-te-zwaar

Tang, T., & Chen, Y. (2024). Colour and furniture brand identity: Exploring the strategic value of brand's iconic colour. *Bioresources, 19*(2), 2763–2781. https://doi.org/10.15376/biores.19.2.2763-2781

Tavakol, M., & Dennick, R. (2011). Making sense of Cronbach's alpha. *International journal of medical education, 2*, 53. https://doi.org/10.5116/ijme.4dfb.8dfd

Tavassoli, N. T., & Lee, Y. H. (2003). The differential interaction of auditory and visual advertising elements with Chinese and English. *Journal of Marketing Research, 40*(4), 468-480. https://doi.org/10.1509/jmkr.40.4.468.19391

Valdez, P., & Mehrabian, A. (1994). Effects of color on emotions. *Journal of experimental psychology: General, 123*(4), 394. https://doi.org/10.1037/0096-3445.123.4.394

van Rompay, T. J., Deterink, F., & Fenko, A. (2016). Healthy package, healthy product? Effects of packaging design as a function of purchase setting. *Food quality and preference, 53*, 84-89. https://doi.org/10.1016/j.foodqual.2016.06.001

Verma, S. (2009). Do consumers respond differently to advertising stimuli: an empirical study. *South Asian Journal of Management, 16*(3), 73-86. https://sajm-amdisa.org/sajm_journals/SAJM_16.3.pdf

Waterlander, W. E., De Mul, A., Schuit, A. J., Seidell, J. C., & Steenhuis, I. H. (2010). Perceptions on the use of pricing strategies to stimulate healthy eating among residents of deprived neighbourhoods: a focus group study. *International Journal of Behavioral Nutrition and Physical Activity, 7*(1), 44. https://doi.org/10.1186/1479-5868-7-44

Wilms, L., & Oberfeld, D. (2018). Color and emotion: effects of hue, saturation, and brightness. *Psychological research, 82*(5), 896-914. https://doi.org/10.1007/s00426-017-0880-8

Wilson E.O. (1984). *Biophilia: The human bond with other species*. Cambridge, MA: Harvard University Press.

World Health Organization. (2002, March 4). Diet, nutrition, and the prevention of chronic diseases (Report No. 916). https://iris.who.int/bitstream/handle/10665/42665/WHO_TRS_916.pdf

World Health Organization. (2024, March 1). Obesity and overweight. *WHO*. https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight

Xia, T., Yan, Y., & Guo, J. (2024). Color in web-advertising: the effect of color hue contrast on web satisfaction and advertising memory. *Current Psychology*, *43*(16), 14645-14658. https://doi.org/10.1007/s12144-023-05429-9

Yu, C. E., Xie, S. Y., & Wen, J. (2020). Coloring the destination: The role of color psychology on Instagram. *Tourism Management*, *80*, 104110. https://doi.org/10.1016/j.tourman.2020.104110

Zailskaitė-Jakštė, L., Ostreika, A., Jakštas, A., Stanevičienė, E., & Damaševičius, R. (2017, May). Brand communication in social media: The use of image colours in popular posts. In *2017 40th International Convention on Information and Communication Technology, Electronics and Microelectronics (MIPRO)* (pp. 1373-1378). IEEE. https://doi.org/10.23919/MIPRO.2017.7973636

Żakowska-Biemans, S., Pieniak, Z., Kostyra, E., & Gutkowska, K. (2019). Searching for a measure integrating sustainable and healthy eating behaviors. *Nutrients, 11*(1), 95. https://doi.org/10.3390/nu11010095

Zhang, K., Hou, Y., & Li, G. (2024). Color and naturalness: How color saturation shapes tourists' perception and purchase intention. *International Journal of Tourism Research, 26*(4), e2717. https://doi.org/10.1002/jtr.2717

Zieliński, P. (2016). An arousal effect of colors saturation: A study of self-reported ratings and electrodermal responses. *Journal of Psychophysiology, 30*(1), 9–16. https://doi.org/10.1027/0269-8803/a000149

Appendices

Appendix A

Pre-test 1: type drink

With the increasing focus on nutrition and the growing popularity of high-protein products (Kale, 2021; Denniss et al., 2023; Scheres, 2024), the stimuli considered for this study included advertisement posters from a fictional company promoting a protein lemonade. A pre-test was conducted to validate whether this product was recognized and relevant for this study to feature on the stimuli, and to compare it with alternative drinks, such as a vitamin drink and an electrolytes drink. The pre-test consisted of a survey, which was divided into several parts. Participants were first asked if they had heard of each of the three drink types: a protein lemonade, a vitamin drink, and an electrolyte drink. For each drink, they rated their familiarity on a five-point Likert scale ranging from 'Not familiar at all' to 'Very familiar'. Additionally, participants indicated the extent to which they perceived the drink as fitting for a healthy food advertisement and targeted for health-conscious consumers using a 5-point Likert scale, ranging from 'Strongly disagree' to 'Strongly agree.'

Moreover, the survey included questions exploring aspects such as perceived advantages and disadvantages, where they expected to find each drink in a supermarket, and who they thought the drink was intended for. Finally, participants were asked which drink appealed to them the most.

A total of 34 participants took part in the pre-test questionnaire. However, eight participants did not complete the survey and were therefore excluded from the data analysis, resulting in a final sample of 26 participants.

Results

Among all participants, the drink that was most recognized was the vitamin drink, with 96% awareness (see Table 10). This was also the drink which participants felt most familiar with, followed by protein lemonade and electrolyte drinks. Table 11 further illustrates how participants rated the suitability of each drink for a healthy food advertisement and whether they believed each drink catered to health-conscious consumers. Protein lemonade was identified as the best fit for a healthy food advertisement, indicating that participants viewed this drink as the most logical choice for the stimuli used in this study. Similarly, participants indicated that protein lemonade was most aimed at health-conscious consumers, reinforcing its association with health.

Table 2

Heard of specific type of drink

Type drink	Yes (n / %)	No (n / %)	Not sure / Don't remember (n / %)
Protein lemonade	18 (69%)	8 (31%)	0 (0%)
Vitamin drink	25 (96%)	0 (0%)	1 (4%)
Electrolytes drink	19 (73%)	7 (27%)	0 (0%)

Table 3

Familiarity, Advertisement Fit, and Health Perception Ratings per drink

		n	Mean	SD
Protein lemonade				
	Familiraty [a)]	26	2.62	1.27
	Fit for ad [b)]	26	3.42	0.99
	Targeted at healthy consumers [b)]	26	4.12	0.77
Vitamin drink				
	Familiraty [a)]	26	3.46	0.91
	Fit for ad [b)]	26	2.77	0.95
	Targeted at healthy consumers [b)]	26	3.27	1.15
Electrolytes drink				
	Familiraty [a)]	26	2.62	1.27
	Fit for ad [b)]	26	3.19	0.80

Table 11 continued

Targeted at healthy consumers [b)]	26	3.58	0.90

a) 5-point liker scale (1=not familar at all / 5=very familiar)

b) 5-point liker scale (1=totally disagree / 5=totally agree)

When analyzing the responses to open-ended questions regarding the advantages and disadvantages of various drinks, several observations emerge. These insights may help explain why participants rated a vitamin drink as a less suitable option for a healthy food advertisement and as not being intended for health-conscious consumers.

For protein lemonade, the expected advantages include high protein content, support for muscle growth and recovery, convenience in increasing protein intake, a dairy-free option, and being a lighter alternative to traditional protein shakes. On the downside, participants mentioned a high price, potential added sugars, possibly unhealthy or processed ingredients, taste concerns, and being unnecessary for individuals who already meet their protein needs, as disadvantages.

For vitamin drinks, the advantages mentioned are extra vitamin intake, perceived health benefits, a refreshing taste, and serving as a healthier alternative to soft drinks. The disadvantages consist of high sugar content, questionable health value (including low vitamin bioavailability and processed ingredients), being unnecessary if one is following an adequate diet, and their high price.

Lastly, for electrolyte drinks, the advantages include helping with hydration, recovery support after working out, replenishment for salts and electrolytes, and providing a possible energy boost. However, the disadvantages participants mentioned were high sugar content, a high price, limited necessity for non-athletes, possibly unhealthy additives, and taste concerns.

Participants were asked where in the supermarket they would expect to find the different drinks. Table 12 indicates that protein lemonade is primarily thought of to be in the

sports drinks sections, reinforcing their health and sport-oriented perception. Electrolyte drinks are even more strongly linked to sports contexts, reinforcing their association with exercise and recovery. In contrast, vitamin drinks are mainly expected to be in the general soft drinks section, suggesting why participants do not perceive this drink as particularly healthy or suitable for a health-focused advertisement. These expectations, together with the reported disadvantages—such as added sugars and cost—help explain why participants rated the vitamin drink lower for "*fit for ad*" and "*targeted at healthy consumers*" compared with protein lemonade and electrolytes drinks.

Table 4

Expected location in supermarket

	Location in supermarket	n	%
Protein lemonade			
	Refrigerated section with healthy drinks	6	23%
	Sport drinks	18	69%
	Soft drinks	1	4%
	Organic products	0	0%
	Other	1	4%
Vitamine drink			
	Refrigerated section with healthy drinks	5	19%
	Sport drinks	7	30%
	Soft drinks	14	54%
	Organic products	0	0%
	Other	0	0%
Electrolytes drink			
	Refrigerated section with healthy drinks	2	8%
	Sport drinks	21	81%
	Soft drinks	2	8%
	Organic products	0	0%
	Other	1	4%

When asked about drink preference, protein lemonade emerged as the most appealing option, selected by 42% of participants. Electrolyte drinks were preferred by 23%, vitamin drinks by 15%, and 19% of participants chose none (See Table 12). These findings suggest that

consumers are drawn to products that align with health and functional benefits, rather than simply relying on familiarity.

Table 5

Appeal

	n	%
Eiwit lemonade	11	42%
Elektrolytes drink	6	23%
None of them	5	19%
Vitamine drink	4	15%

Conclusion

The pre-test offered valuable insights into consumer perceptions and preferences regarding protein lemonade, vitamin drinks, and electrolyte drinks. This was used to determine which drink would be most suitable for the stimuli used in this study. The results indicated that while all three drink types were familiar to the participants to varying degrees, vitamin drinks were the most recognized. Protein lemonade and electrolyte drinks were strongly associated with sports, recovery, and health-focused consumption, whereas vitamin drinks were primarily associated with soft drinks, which may diminish their perceived healthiness. Additionally, participants found protein lemonade to be the most appealing option among the three drinks, and as highest fit for a healthy food advertisement. Although protein lemonade was not the most recognized, it emerged as the most relevant choice for this study based on the overall results. Therefore, a protein lemonade from a fictional company was selected to be featured on the stimuli.

Appendix B

Full item list

Table 6

Full item list

	Item	Measurement
Demographics		
	What is your age?	Open question (1-99)
	What is your gender?	Multiple choice (Male, Female, Other, Prefer not to say)
	What is the highest level of education you have completed?	Multiple choice (No education, Primary/Elementary school, Vocational education (MBO), Bachelor's degree (HBO/WO), Master's degree (HBO/WO), PhD,Doctoral program)
Perception of naturalness		
	This advertisement suggests that this is a healthy product.	7-point likert scale (ranging from 1 = Not at all, 2 = Slightly, 3 = Somewhat 4 = Moderately, 5 = Quite a bit, 6 = Very much, 7 = Completely so)
	This advertisement suggests that this is a pure product.	
	This advertisement suggests that this is a fresh product.	
	This advertisement suggests that this is a natural product.	
	This advertisement suggests that this is a wholesome product	
	This advertisement suggests that this is an honest product.	
Attitude		
	After seeing this advertisement, I feel that this product is: - Unappealing:Appealing	Bipolar
	After seeing this advertisement, I feel that this product is: - Something I would not like to try:Something I would like to try	
	After seeing this advertisement, I feel that this product is: - Unenjoyable:Enjoyable	

Table 14 continued

	After seeing this advertisement, I feel that this product is: - Unpleasant:Pleasant	
	After seeing this advertisement, I feel that this product is: - Tasteless:Tasteful	
	After seeing this advertisement, I feel that this product is: - Poor quality:High quality	
	After seeing this advertisement, I feel that this product is: - Unhealthy:Healthy	Bipolar
	After seeing this advertisement, I feel that this product is: - Harmful:Beneficial	
	After seeing this advertisement, I feel that this product is: - Undesirable:Desirable	
	After seeing this advertisement, I feel that this product is: - Not for me:For me	
	After seeing this advertisement, I feel that this product is: - Not refreshing:Refreshing	
Emotional response (feeling)		
	The advertisement made me feel excited (about the product).	
	The advertisement made me feel interested (about the product).	
	The advertisement made me feel inspired (about the product).	7-point likert scale (ranging from 1 = Strongly disagree, 2 = Disagree, 3 = Somewhat disagree 4 = Neither agree nor disagree, 5 = Somewhat agree, 6 = Agree, 7 = Stongly agree)
	The advertisement made me feel happy (about the product).	
	The advertisement made me feel hopeful (about the product).	
	The advertisement made me feel energetic (about the product).	
	The advertisement made me feel confident (about the product).	
	The advertisement made me feel skeptical (about the product).	
Brand impressions		
Sincerity		
	This advertisement suggests that this brand is down-to-earth.	
	This advertisement suggests that this brand is honest.	7-point likert scale (ranging from 1 = Strongly disagree, 2 = Disagree, 3 = Somewhat disagree 4 = Neither agree nor disagree, 5 = Somewhat agree, 6 = Agree, 7 = Stongly agree)
	This advertisement suggests that this brand is wholesome.	
	This advertisement suggests that this brand is cheerful.	

Table 14 continued

Excitement	This advertisement suggests that this brand is daring.	7-point likert scale (ranging from 1 = Strongly disagree, 2 = Disagree, 3 = Somewhat disagree 4 = Neither agree nor disagree, 5 = Somewhat agree, 6 = Agree, 7 = Stongly agree)
	This advertisement suggests that this brand is spirited.	
	This advertisement suggests that this brand is imaginative.	
	This advertisement suggests that this brand is up to date.	
Competence		
	This advertisement suggests that this brand is reliable.	
	This advertisement suggests that this brand is intelligent.	
	This advertisement suggests that this brand is successful.	
Sophistication		
	This advertisement suggests that this brand is upper class.	
	This advertisement suggests that this brand is charming.	
Ruggedness		
	This advertisement suggests that this brand is outdoorsy.	
	This advertisement suggests that this brand is tough.	
Price expectancy	What do you think the price of this protein lemonade is? Please indicate the expected price in Euros (€)	Open question
Sensitivity to design		
	Seeing advertisements with superior designs makes me feel good.	7-point likert scale (ranging from 1 = Not at all, 2 = Slightly, 3 = Somewhat 4 = Moderately, 5 = Quite a bit, 6 = Very much, 7 = Very much so)
	I enjoy seeing displays of advertisements that have superior designs.	
	An advertisement's design is a source of pleasure for me.	
	Beautiful advertisement designs make our world a better place to live.	
	Being able to see subtle differences in advertisement designs is one skill that I have developed over time.	
	I notice things in an advertisement's design that other people tend to overlook.	
	I have a pretty good idea of what makes one advertisement look better than its competitors.	
	Sometimes the way an advertisement looks seems to reach out and grab me.	
	If an advertisement's design really “speaks” to me, I feel that I must buy the product.	

Table 14 continued

	When I see an advertisement that has a really great design, I feel a strong urge to buy the product.	7-point likert scale (ranging from 1 = Not at all, 2 = Slightly, 3 = Somewhat 4 = Moderately, 5 = Quite a bit, 6 = Very much, 7 = Very much so)
Eating habits		
	I choose food that is nutritious.	7-point likert scale (ranging from 1 = Never, 2 = Rarely, 3 = Occasionally, 4 = Sometimes, 5 = Frequently, 6 = Usually, 7 = Always)
	I choose food that keeps me healthy.	
	I avoid sugary drinks.	
	I choose food that contains a lot of vitamins and minerals.	
	I choose food that contains natural ingredients.	
	I choose food that contains no additives (ingredients to improve the food's shelf life, appearance, flavor, or texture—such as stabilizers, emulsifiers, or sweeteners).	
	I try to have a balanced diet.	
	I choose food that contains no artificial ingredients (ingredients produced in a lab, such as artificial colors, flavors, or preservatives that do not occur naturally in the food).	
	I choose whole grains products.	
	I limit my salt usage.	
Manipulation check		
	How many different colors did you perceive in the advertisement's background? Few:Many	Bipolar
	To what extent did you find the colors in the advertisement background to be intense? Not intense:Intense	

Appendix C

Reliability results

Table 7

Cronbach's alpha values for measures

	Cronbach's alpha
Perception of naturalness	0.7850302
Attitude	0.9070331
Emotional response (feeling)	0.9023265*
Brand impressions	
Sincerity	0.7599036*
Excitement	0.7017748
Compentence	0.7998143
Sophistication	NA
Ruggedness	NA
Sensitivity to design	0.8996214
Eating habits	0.8338093*

*Recalculated Cronbach's alpha after deleting affecting item

Table 8

Correlation and reliability values of Sophistication and Ruggedness

	Correlation	Reliability
Sophistication	0.4321397	0.6034882
Ruggedness	0.3522797	0.521016

Appendix D

Ethical Approval

UNIVERSITY OF TWENTE.

Dear Emma Fahner,

This is a notification from the Humanities & Social Sciences (HSS) Ethics Committee to inform you that your research project has received a **positive advice.**

Application nr.	**:** 250381
Title	**:** The impact of hue and saturation on consumer perception of naturalness in healthy food advertisements
Application date	**:** 13-May-2025
Researcher	**:** Emma Fahner
Supervisor	**:** Thomas van Rompay
SONA	**:** Yes
Date of advice	**:** 22-May-2025

The ethics committee has reviewed the ethical aspects of your research project. Based on the information you have provided in the web application, the ethics committee has no major ethical concerns for the research project to go forward as proposed. Please find attached the PDF with the application together with the review comments and advice.

It is your responsibility to ensure that the research is carried out in line with the information provided.

Future communication regarding this research project should also be directed to the secretary of the HSS Ethics Committee via ethicscommittee-hss@utwente.nl, stating the Application nr. 250381.

If you later make considerable changes to the research project that might affect the ethical aspects or raise new ethical concerns, you must submit an amendment. For this, please send a concise description of the intended changes to the secretary of the HSS Ethics Committee, stating the Application nr. 250381. An additional review of the proposed changes will be performed.

Best regards,

Humanities & Social Sciences (HSS) Ethics Committee

Appendix E

Informed consent form

TITLE OF STUDY: 'Consumer responses to advertisements' (placeholder name)

PURPOSE OF THE RESEARCH

You are invited to take part in a research study about how people respond to advertisements. The purpose of this study is to explore how various elements of advertisements affect people's impressions and responses. This research is conducted by Emma Fahner, a Master student in Communication Science at the University of Twente. The study is supervised by dr. T.J.L. van Rompay and drs. M.H. Tempelman. The research is reviewed and approved by the BMS Ethics Committee.

PROCEDURE

1. Before beginning, you will be asked to complete a brief color vision test to ensure the accuracy of responses.
2. You will be asked to view an advertisement of a fictional company and answer questions about your reactions and opinions. There are no right or wrong answers—this study is simply interested in your personal perceptions.

VOLUNTARY PARTICIPATION AND DATA STORAGE

Your participation in this research is entirely voluntary. You have the right to withdraw from the study at any time and for any reason, without needing to provide an explanation. You have the right to request access to your data, as well as to request its rectification or erasure. The data will be collected through a questionnaire administered via Qualtrics and will be stored in an anonymized format. Access to the data will be limited to the research team (the researcher and their supervisors). The anonymized collected data will be used by the researcher to write their Master thesis and will be stored in a secure online environment for a period of five years.

CONTACT INFORMATION

In the case of questions, suggestions, or concerns, please feel free to contact the researcher or their supervisors.

Researchers	**Supervisors**
Emma Fahner (e.l.fahner@student.utwente.nl)	Thomas van Rompay (t.j.l.vanrompay@utwente.nl)
	Mark Tempelman (m.h.tempelman@utwente.nl)

If you have questions about your rights as a research participant, or wish to obtain information, ask questions, or discuss any concerns about this study with someone other than the researcher(s), please contact the Secretary of the Ethics Committee/domain Humanities & Social Sciences of the Faculty of Behavioural, Management and Social Sciences at the University of Twente by ethicscommittee-hss@utwente.nl

CONSENT

You will be given a copy of the study information and this form.

Please tick the appropriate boxes	**Yes**	**No**
A: GENERAL AGREEMENT – RESEARCH GOALS, PARTICPANT TASKS AND VOLUNTARY PARTICIPATION		
1. I have read and understood the study information. I have been able to ask questions about the study and my questions have been answered to my satisfaction.	☐	☐
2. I consent voluntarily to be a participant in this study and understand that I can refuse to answer questions, and I can withdraw from the study at any time, without having to give a reason.	☐	☐
3. I understand that taking part in the study involves: • Taking a brief test to screen for color vision deficiency • Filling in a questionnaire after seeing an advertisement	☐	☐
B: POTENTIAL RISKS OF PARTICIPATING (INCLUDING DATA PROTECTION)		
4. I understand that personal information collected about me that can identify me (e.g. my name), will not be shared beyond the study team.	☐	☐
5. I understand that the following steps will be taken to minimize the threat of a data breach, and protect my identity in the event of such a breach: • Anonymous data collection • Secure data protection where only the researcher and supervisors have access to	☐	☐
6. I understand that the data I provide will be destroyed after five years.	☐	☐
C: RESEARCH PUBLICATION, DISSEMINATION AND APPLICATION		
7. I understand that after the research study the de-identified information I provide will be used for writing the researcher's Master thesis	☐	☐

Signatures

_____	_____	_____
Name of participant [printed]	Signature	Date

I, as researcher, have accurately read out the information sheet to the potential participant and, to the best of my ability, ensured that the participant understands to what they are freely consenting.

_____	_____	_____
Name of the Researcher [printed]	Signature	Date

Appendix F

ANCOVA table

Table 9

ANCOVA results

		Sum Sq	df	F-value	p
Perception of naturalness					
	Hue diversity	5.32	1	4.09	0.045*
	Saturation level	7.82	1	6.02	0.015*
	Sensitivity to design	0.00	1	0.00	0.956
	Eating habits	2.20	1	1.69	0.195
	Hue diversity × saturation level	2.02	1	1.56	0.164
	Hue diversity × sensitivity to design	2.49	1	1.91	0.226
	Saturation level × sensitivity to design	2.97	1	2.29	0.164
	Hue diversity × saturation level × sensivity to design	0.91	1	0.70	0.144
	Residuals	196	151	NA	NA
Attitude					
	Hue diversity	1.18	1	1.05	0.307
	Saturation level	2.72	1	2.42	0.122
	Sensitivity to design	0.00	1	0.00	0.983
	Eating habits	0.01	1	0.01	0.917
	Hue diversity × saturation level	1.43	1	1.27	0.261
	Hue diversity × sensitivity to design	0.91	1	0.81	0.369
	Saturation level × sensitivity to design	0.83	1	0.73	0.396
	Hue diversity × saturation level × sensivity to design	1.35	1	1.20	0.274
	Residuals	170	151	NA	NA
Emotional response (feeling)					
	Hue diversity	1.69	1	1.36	0.246
	Saturation level	4.67	1	3.74	0.055
	Sensitivity to design	1.00	1	0.80	0.372
	Eating habits	0.08	1	0.07	0.797
	Hue diversity × saturation level	2.44	1	1.95	0.164
	Hue diversity × sensitivity to design	1.85	1	1.48	0.226
	Saturation level × sensitivity to design	2.43	1	1.95	0.164
	Hue diversity × saturation level × sensivity to design	2.69	1	2.16	0.144
	Residuals	188	151	NA	NA
Sincerity					
	Hue diversity	5.16	1	3.65	0.058
	Saturation level	7.12	1	5.03	0.026*
	Sensitivity to design	0.42	1	0.30	0.588
	Eating habits	3.33	1	2.35	0.127
	Hue diversity × saturation level	3.24	1	2.29	0.132

Table 17 continued

	Hue diversity × sensitivity to design	5.47	1	3.87	0.510
	Saturation level × sensitivity to design	3.18	1	2.25	0.136
	Hue diversity × saturation level × sensivity to design	3.38	1	2.39	0.125
	Residuals	214	151	NA	NA
Excitement					
	Hue diversity	0.38	1	0.35	0.557
	Saturation level	3.12	1	2.84	0.094
	Sensitivity to design	0.55	1	0.50	0.480
	Eating habits	2.26	1	2.06	0.154
	Hue diversity × saturation level	1.50	1	1.37	0.244
	Hue diversity × sensitivity to design	0.54	1	0.49	0.484
	Saturation level × sensitivity to design	1.42	1	1.29	0.258
	Hue diversity × saturation level × sensivity to design	1.83	1	1.66	0.199
	Residuals	166	151	NA	NA
Competence					
	Hue diversity	0.14	1	0.10	0.751
	Saturation level	0.64	1	0.48	0.489
	Sensitivity to design	1.41	1	1.05	0.306
	Eating habits	0.19	1	0.14	0.707
	Hue diversity × saturation level	0.14	1	0.11	0.746
	Hue diversity × sensitivity to design	0.02	1	0.02	0.894
	Saturation level × sensitivity to design	3.03	1	2.26	0.134
	Hue diversity × saturation level × sensivity to design	6.61E-08	1	4.9E-08	1.000
	Residuals	202	151	NA	NA
Sophistication					
	Hue diversity	0.04	1	0.02	0.882
	Saturation level	0.30	1	0.19	0.668
	Sensitivity to design	0.94	1	0.57	0.450
	Eating habits	1.23	1	0.75	0.388
	Hue diversity × saturation level	0.00	1	0.00	0.974
	Hue diversity × sensitivity to design	0.13	1	0.08	0.777
	Saturation level × sensitivity to design	0.06	1	0.03	0.855
	Hue diversity × saturation level × sensivity to design	0.04	1	0.03	0.873
	Residuals	247	151	NA	NA
Ruggedness					
	Hue diversity	7.19	1	4.86	0.029*
	Saturation level	0.45	1	0.31	0.581
	Sensitivity to design	0.39	1	0.27	0.607
	Eating habits	0.36	1	0.24	0.625
	Hue diversity × saturation level	1.77	1	1.19	0.276
	Hue diversity × sensitivity to design	7.44	1	5.03	0.026*
	Saturation level × sensitivity to design	0.27	1	0.18	0.669
	Hue diversity × saturation level × sensivity to design	2.98	1	2.02	0.158
	Residuals	223	151	NA	NA
Price expectancy					

Table 17 continued

Hue diversity	8.23	1	0.82	0.368
Saturation level	0.94	1	0.09	0.760
Sensitivity to design	0.75	1	0.07	0.786
Eating habits	0.88	1	0.09	0.769
Hue diversity × saturation level	5.91	1	0.59	0.445
Hue diversity × sensitivity to design	5.66	1	0.56	0.455
Saturation level × sensitivity to design	7.04	1	0.70	0.404
Hue diversity × saturation level × sensivity to design	0.51	1	0.05	0.822
Residuals	1522	151	NA	NA

* significant at the 0.05 level (2-tailed)