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AN EXPERIMENTAL STUDY ON THE IMPACT OF COLOR VARIETY ON THE PERCEPTION OF SNACK FOOD PRODUCTS

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Dissertation presented as partial requirement for obtaining
the Master's degree in Information Management

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by

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Dissertation presented as partial requirement for obtaining the Master's degree in Information Management, with a specialization in Marketing Intelligence

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ABSTRACT

Despite people's intentions on eating healthier, obesity rates have been on the rise. The increase in caloric intake and energy-dense foods between main meals (unhealthy snacks) represent an accounting explanation for increased obesity. Evidently, people often rely on their perceptions rather than on nutritional information, thus visual properties of snacks, including color variety, might be an important cue to promote healthy snacking choices. Research exploring the impact of color variety on the perceptions of snacks is limited, particularly in adults. This research addresses this gap by investigating, through an experimental approach, the influence of high color variety (vs. low color variety) on adults' perceptions of taste, desire, and healthiness for healthy and unhealthy snacks. Participants were randomly exposed to one of four different snacking images: healthy or unhealthy snacks containing high or low color variety. Both healthy and unhealthy snacks were perceived as tastier when high in color variety (vs. low color variety) and the influence of high-color variety was associated with a stronger desire for healthy snacks. While no influence of color variety was found on the perceived healthiness of unhealthy snacks, healthy snacks high in color variety were perceived as healthier. The implications of this research for companies, consumers, and the public health community are discussed.

KEYWORDS

Snacks; Color Variety; Eating Behavior; Visual Cues; Food Perception; Experimental Design Research; Healthy Snacks; Unhealthy Snacks

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1. INTRODUCTION

Despite people's intentions of eating healthily have been growing over the years (de Ridder, Kroese, et al., 2017; Schlinkert et al., 2020), the number of obese and overweight people has been increasing in epidemic proportions, to the extent where its prevalence more than doubled since 1980. Obesity is caused by an energy imbalance between the calories consumed and calories spent (Hassan et al., 2015), yet it is considered to be largely preventable (Ofei, 2005). People, however, are failing to follow a healthy diet, since the main increase in caloric intake in the last decades, is coming from calories consumed in snacks, often unhealthy (Cutler et al., 2003). In short, unhealthy snacking habits are a major contributor to the increased rates of obesity and overweight (Malik et al., 2010) which shows that people's actual behavior is not complying with their intentions of eating healthy.

This happens because people often rely on their perceptions to create expectations of the taste, quality, and even nutritional value of food (Clydesdale, 1993; Scheibehenne et al., 2010; Spence, 2015; van der Laan et al., 2011). In most cases, except perhaps the dine-in-the-dark restaurants, we eat with our eyes first (Spence & Piqueras-Fiszman, 2014). Thus, it is no surprise that visual properties have always had a big influence on our judgments of food. Ever since the Middle Ages, for instance, colorful and theatrical food was highly present in the elite cuisine of Europeans (Woolgar, 2018). The appearance of food played such an important role that many dishes were even named specifically for their color. Hence, dishes such as "black pepper broth", "yellow potage" or "blancmange", are still well-known with regards to their color (Clark & Adamson, 2006). If we go even further back in the past, we can remember how ancient Egyptians around 400 BC used already artificial colors from vegetables and mineral sources to color other foods (e.g., wine and candy) (Downham & Collins, 2000). Just like in the modern days, colors were added to bring a visual cue for quality, to make it perceivably more appealing, and to meet consumer expectations.

As people snack unhealthily not because of their conscious intentions but mostly by habit (Verhoeven et al., 2012) or because of taste associations and expectations (Glanz et al., 1998), it is worth taking special attention to the color of snacks, since it might be an important cue to increase the desire and promote healthy snacking choices instead.

Even though there is extensive research on the effect of food color on consumer's perception and intake, most were conducted using color additives or single-colored food stimuli (e.g., Clydesdale, 1993; L. L. Garber et al., 2000; Geier et al., 2012). For instance, most research on the psychological influence of color on taste was mainly conducted with beverages (Koch & Koch, 2003; STILLMAN, 1993; Strugnell, 1997), due to greater ease in its manipulation (Spence, 2015); and has primarily involved children (Piqueras-Fiszman & Spence, 2014). Additionally, several studies approached either a specific food or meal events such as breakfast, lunch, or dinner but really few focused solely on the snacks category (Rolls et al., 1982). Nevertheless, it has been suggested that multi-colored food can be used to manipulate consumers' cravings and intake (Rolls et al., 1982). However, to the best of our knowledge, the previous studies regarding color variety, have mainly focused on the intake and SSS (Sensory Specific Satiety). Therefore, there is a lack of studies analyzing the effect color variety has on snack perception, simply by looking at it (instead of actual intake).

By exploring the apparent gap in the snacks category, regarding adults' perception of multicolored snacks, the present study examines the influence of high color variety (vs. low color variety) on the perceived taste, desire, and healthiness of healthy and unhealthy snacks. The critical question of this study is then presented: "Does color variety impact consumers' perceptions of snacks? If so, can it lead to a healthier snacking consumption?"

This paper starts with an extensive literature review to further improve the understanding of several concepts such as healthy and unhealthy snacks, visual cues, and consumers' intentions and behaviors. Next, we define the proposed hypothesis and the respective model of this study based on the literature reviewed. We then define the method and describe the design of the experiment. The findings and results are then obtained and explained. And finally, we discuss the contributions and implications that these results bring, ending with the limitations of the current study and possible developments for further research on this topic.

2. THEORETICAL FRAMEWORK AND HYPOTHESIS DEVELOPMENT

The world is changing at a fast pace, and so are people's eating habits (J. O. Hill et al., 2003). People's lives are becoming busier, and snacking comes as a great solution to save time, as opposed to preparing traditional meals. As revealed by the 2015 Scientific Report of the Dietary Guidelines Advisory Committee, most of the U.S. population (96%) is consuming at least one snack a day (excluding people aged younger than 2 years old). Therefore, snacking is becoming more common (Piernas & Popkin, 2010) and as a result, how, where, and when we eat, has been shifting from traditional meals to snack events in the last decades (J. O. Hill et al., 2003).

2.1. DEFINING SNACKS

There have been several authors defining "snacks" in the literature. However, the definition of "snacks" is not static (J. M. Hess et al., 2016; Johnson & Anderson, 2010) and many publications are not consistent with the definition of either "snacks", "snacking" or "snack foods" (Hess & Slavin, 2018). In the literature, the term "snack" has been defined for example, based on the time of the day when eating occurs (Duffey et al., 2013; Garriguet, 2007; Ma et al., 2003; Ng et al., 2011; Ovaskainen et al., 2010). For instance, de Graaf (2006) defined it as food consumed outside the three main meals (breakfast, lunch, and dinner). Other authors have defined it based on the type of food, its amount, the location where it was consumed, or a combination of more than one of these factors (see Nicklas et al., 2003; Ovaskainen et al., 2006; Z. Wang et al., 2012). Furthermore, some studies also use the term "snack foods" or its short form "snack", to talk about energy-dense, nutrient-poor foods such as cakes, cookies, chips, and sugar-sweetened beverages (Bellisle, 2014; J. M. Hess et al., 2016; J. M. Hess & Slavin, 2018).

Although "snacks" are often associated with "unhealthy" foods, this is inaccurate. Not every "snack" is caloric and nutrient-poor. In fact, the 2014 National Eating Trends survey, reported that fruit was the most popular "snack" category chosen by the U.S. population (J. Hess et al., 2017). Other categories in the survey included cookies, chips, ice cream, candy, popcorn, soft drinks, crackers, cake, milk, nuts and seeds, tea, and yogurt. Some of these foods (fruit, yogurt, milk, nuts, and seeds) are nutrient-dense snacks as they provide vitamins, minerals, and other healthy components (UDSA, 2020). Additionally, the 2020 DGA states that snacks can be useful to promote the intake of other nutrient-dense foods such as carrot sticks, hummus, or even apple slices. Thus, in this study "snacks" will refer to foods consumed outside the main meals, regardless of whether healthy or unhealthy choices are consumed.

2.2. HEALTHY & UNHEALTHY SNACKS

Nowadays, snacking contributes to almost one-third of the daily energy intake (D. Wang et al., 2018). However, most of the current snack choices are energy-dense and nutrient-poor foods (unhealthy snacks) (Njike et al., 2016). As previously discussed, unhealthy eating habits can have serious consequences on people's health, as it increases the risk of people developing noncommunicable diseases such as diabetes, heart diseases, and strokes (Boutayeb & Boutayeb, 2005; Olatona et al.,

2018; Swinburn et al., 2013). Additionally, unhealthy eating, including the consumption of unhealthy snacks, has a great impact on people's well-being (el Ansari et al., 2014; Hong & Peltzer, 2017; Zahedi et al., 2014). For instance, a study by Smith & Rogers (2014) showed that consuming chocolate leads to a higher level of anxiety, depression, and emotional distress when compared to consuming fruit. By contrast, the consumption of vegetables and fruit is positively associated with happiness and general well-being (Blanchflower et al., 2013; White et al., 2013).

That is why health organizations and governments have been increasingly concerned about obesity and overweight rates (J. O. Hill et al., 2003; James et al., 2001), taking action to reduce the consumption of unhealthy products and educating the population on the importance of eating healthily. In the past years, for example, many countries have introduced taxes on unhealthy food and drinks (Mytton et al., 2012), and promoted education about nutrition (Drewnowski & Rolls, 2005). But such efforts are not enough when marketing campaigns and ads target and heavily emphasize to consumers that the features associated with unhealthy snacks (sweet, salty, and fat) represent tastiness (Raghunathan et al., 2006; Schlinkert et al., 2020). If we consider that unhealthy snacks are being marketed as tasty and that taste expectations are one of the main factors when deciding what to eat (Glanz et al., 1998; Kourouniotis et al., 2016; Li et al., 2019), it clearly makes it harder for people to follow their goals on pursuing a healthy diet.

Moreover, even if consumers understand that unhealthy snacks have bad consequences for their health, those conscious thoughts tend to arrive later than their actions (Libet, 1985; Soon et al., 2008). That happens because people look for immediate gratification (O'Donoghue & Rabin, 2000) and the consequences of unhealthy eating aren't so immediate, but the satisfaction is (Chance et al., 2014; Wertenbroch, 1998). For example, it feels good to eat chips in the moment (present benefit), but if repeated and eaten in large amounts, it can lead to overweight or health issues (uncertain future cost).

And again, it is harder for consumers to resist the temptation of unhealthy snacks because they are highly associated with being tasty, requiring big self-control which people mostly lack when tired, stressed, sick or hungry (Schmeichel, 2007; J. Wang et al., 2010). Hence, most food choices are done mindlessly, meaning that consumers' eating decisions are not based on logic or factual reasoning (such as nutritional value) but are rather urged by impulses and unconscious decisions (Bargh, 2002; Hofmann et al., 2008; Wansink, 2010). As revealed in one study, marketing Subway (a fast-food restaurant) as healthy, makes people to wrongly expect that they will consume fewer calories, making it more likely for them to order caloric side dishes, such as drinks and desserts when compared to a restaurant that does not (Chandon & Wansink, 2007).

Thus, it has been suggested that strategies such as convincing people of what is "healthy" or what is "good for their health", are not the best approach to promote healthy eating, since it requires people to think about their food choices, which they often don't (Kroese et al., 2016). Besides, consumers often judge their eating experience as less pleasant when focusing on health facts (Liem et al., 2012; Raghunathan et al., 2006). Instead, it is more efficient to apply sensory cues that automatically lead individuals to pursue a healthier diet. For example, people are more likely to opt for fruits (healthy) than cookies and cakes (unhealthy) when presented in a larger assortment compared to a smaller assortment (Sela et al., 2009), and to consume more when presented with larger containers or larger portions (Marchiori et al., 2012).

Hence, one does not need to stop snacking to eat healthily, as snacks can contribute to a better and healthier diet (Hartmann et al., 2013; Zizza & Xu, 2012) if the food consumed is nutrient-dense, provides vitamins, minerals, and other healthy components and contains little added sugars, saturated fat, or sodium (e.g., vegetables and fruits) (UDSA, 2020). Which here we call “healthy snacks”. But surely, there is a need to use such strategies to improve the appeal of healthy snacks, for example, by making them more visually pleasing to consumers, and directing them to eat healthier.

2.3. PSYCHOLOGICAL IMPACT OF FOOD COLOR

Most sensory cues, such as taste, appearance, odor, texture, and temperature, impact consumers eating choices (Wadhera & Capaldi-Phillips, 2014). Taste, for instance, is a highly considered factor when deciding what and how much to eat (Glanz et al., 1998). Nevertheless, our tasting experience oftentimes starts long before intake, since we automatically set expectations based on both product-extrinsic cues (e.g., brand and package) and product-intrinsic cues (e.g., smell and color) (Deliza & Macfie, 1996; Piqueras-Fiszman & Spence, 2015; Spence, 2015). Therefore, visual properties have always had a big influence on our judgments of food, as in most cases, except perhaps the dine-in-the-dark restaurants, we eat with our eyes first (Spence & Piqueras-Fiszman, 2014). This can be seen in two studies, a first study where the mousse presented on a white plate was considered to have a sweeter taste and be more flavored than when presented on a black plate (Piqueras-Fiszman et al., 2012), and a second one, that concluded that hot chocolate served from orange cups was judged to have a stronger flavor (Piqueras-Fiszman & Spence, 2012).

Because consumers often rely on the visual aspects of food (Koch & Koch, 2003), their judgments are based on what looks pleasant and tasty, and ultimately, results as one main factor for deciding what to purchase and eat (Cardello, 1996). For instance, color may impact how sweet or sour the food presented is perceived (Walsh et al., 1990). Particularly, red is often associated with being sweet as it is commonly present in strawberry and cherry-flavored products. On the other hand, yellow is more associated with sour citrus flavors, such as lemon, while unripe fruit may come to mind when thinking of the flavor of green-colored food, which is less sweet (Alley & Alley, 1998). Yet, it is important to keep in mind that such taste-color associations are done unconsciously, and it is an automatic process people go through (Wadhera & Capaldi-Phillips, 2014), based on what they already know or have previously experienced. In fact, subjects identified correctly more times the flavor of food when it had color than when left uncolored, even if they were asked not to consider the color when identifying those flavors (Spence et al., 2010; Stillman, 1993).

Moreover, consumers tend to better accept food that has the expected color compared to when they are colorless or atypically colored (Christensen, 1985; DuBose et al., 1980). Consequently, color can influence intake, but it can also lead to its avoidance. As discussed before, many of our eating decisions are based on the expectations we create from the visual characteristics of food, including color. Thus, color can also have the reverse impact if it does not match the expected taste, ending up provoking unpleasant food experiences (Carlsmith & Aronson, 1963). For example, when Miller and Pepsi launched a clear beer and a clear cola (Crystal Pepsi) respectively, none had much success and ended up being removed from the market (L. Garber et al., 2000), which might have happened because consumers expected a different flavor from it. Furthermore, colors that we associate with spoiled food can have a big impact on consumers' behavior, specifically to avoid such foods (Spence, 2015).

Thus, variations and changes in the appearance of food, especially color, have a great impact on its acceptability, perceived quality, and taste intensity (DuBose et al., 1980; Norton & Johnson, 1987; Pangborn, 1960; Walsh et al., 1990). For example, several studies show that people consider red-colored solutions to be sweeter than uncolored ones (J. L. Johnson et al., 1982; Lavin & Lawless, 1998; Pangborn, 1960; Strugnell, 1997) while another research, also using the red color, found that darker solutions are perceived sweeter than lighter solutions (DuBose et al., 1980; J. Johnson & Clydesdale, 1982; Shankar et al., 2009). Additionally, Morrot et al. (2001) concluded in their study that white wine, artificially manipulated to present a red color, was associated with the smell of red wine, even if the dye was odorless. Hence, both the color itself and its intensity provide important sensory information (Wadhwa & Capaldi-Phillips, 2014), which can affect the perception of smell and taste qualities, misleading the ability of consumers to judge the food. Finally, color can also influence the perceived healthiness of food. In a study by Madzharov et al. (2016), participants considered light-colored hedonic foods to be healthier than dark-colored foods. Overall, one can conclude that color can affect perceived taste, smell, and healthiness which has an influence on food choice and intake.

2.4. FOOD COLOR VARIETY

Almost every human being has experienced a desire for a certain food. At this right moment, probably some of us are craving something even if we are not hungry or thirsty, and maybe neither we are sure why are we thinking about it. Truth is that one sole action like a simple and quick look at food can automatically increase subjective feelings of appetite or hunger (Bossert-Zaudig et al., 1991) and those sensations can easily distract us from the fact that we might not even be hungry, yet psychologically, we feel the desire to eat. Craving a food item is an intense feeling for a desired stimulus (Belk et al., 2003), in often cases for unhealthy foods, high in sugar and fat (D. J. Moore & Konrath, 2015). Interestingly, such desires often arise as an automatic reaction to environmental cues (Kavanagh et al., 2005). For instance, it was reported that food advertising containing color originates a stronger craving than black and white advertising (D. J. Moore & Konrath, 2015). Consequently, when people are exposed to attractive foods, there is a propensity for an increase in desire and intake (A. J. Hill et al., 1984; Zellner et al., 2011). Moreover, Rolls et al. (1981) evaluated the effect of offering differently flavored and colored yogurts (hazelnut, orange, and blackcurrant) on intake, and concluded that participants ate more when offered the three possible flavors than when offered just one. Interestingly, if the color of the yogurts was held constant, such effect was mitigated.

Therefore, the perceived and actual color variety of food can also impact consumers' behavior in several ways. For once, consumers tend to underestimate food quantity when presented with multiple colors (vs. single-color). In a study by Redden & Hoch (2009), subjects were shown a clear bowl with M&M's and asked to add the same amount of that candy to a new bowl. The participants given more than one colored M&M's poured more quantity into the container than those who had the single-colored M&M's (Redden & Hoch, 2009). Since this effect was also seen with non-food products, these authors reasoned that it is harder for people to group several objects into one when they are different, making it seem like a smaller amount.

However, the effects that color variety has on our perceptions go far beyond underestimating perceived quantity. The results of a previous study demonstrated that a pink mousse on a white plate was perceived as sweeter, tastier, and more pleasant than the same mousse on a black plate (Piqueras-

Fiszman et al., 2012). Similarly, a “balanced” plate with food of various colors was considered more attractive than a “balanced” single-colored plate (Zellner et al., 2010). This sensory bias shows how a bigger color contrast and variety can impact our flavor perceptions, liking, and even acceptance of food. Research has also shown that subjects tend to eat more from transparent packages (rather than opaque packages) when the unhealthy snack is more visually appealing (Deng & Srinivasan, 2013). Contrarily, people eat less from transparent packages when consuming single-colored vegetables (healthy snacks). One reason for this behavioral difference might be that color variety enhances palatability and consequently desirability, while single-colored healthy food suppresses perceived tastiness.

In a similar vein, we can see that people highly associate unhealthy foods with being tastier and more satisfying than healthy foods, but the desire for such foods mostly comes from preconceptions and taste expectations. Besides, with such a variety of snack options nowadays, people eating choices are even more dependent on their perceptions, which makes it even more important to improve consumers’ impressions of healthy snacks. Note that people believe that choosing healthy foods is a good decision, they just think that to do it, one needs a lot of self-control, as they don’t associate healthy food to be as tasty (Cornil & Chandon, 2016). Nevertheless, color variety, for instance, might help change the preconceived idea that healthy food is less tasty by making it more visually appealing. In fact, a study investigating the hypothesis that eating colorful is eating healthy disclosed that participants found those colorful meals to be more tasty and pleasant (König & Renner, 2019).

Based on the mentioned above, we start by investigating the effect that color variety has on the perceived taste of snacks. This leads to our first hypothesis:

H1: Multi-colored snacks will be perceived as tastier than single-colored snacks.

Moreover, even if the desire for a specific food is likely to increase when there are positive taste associations concerning that food (Roininen & Tuorila, 1999), taste alone may not always lead to a stronger desire to eat nor does always influence food intake. For instance, it was suggested that color variety didn’t influence the intake of chocolate candies, since people’s intake was similar for multi-colored and single-colored candies (Rolls et al., 1982). On the other hand, the same might not apply to healthy snacks as studies have shown that people ate more healthy foods when food was available in a variety set compared to a single set (Keim et al., 2014; Meengs et al., 2012). Plus, craving and desire were shown to enhance food intake (Chao et al., 2014; Massicotte et al., 2019; Nederkoorn et al., 2000). Based on this, we hypothesize that color variety positively affects the desire for healthy but not unhealthy foods. Specifically:

H2: Multi-colored healthy snacks will be more desired than single-colored healthy snacks, whereas color variety doesn’t affect the desirability of unhealthy snacks.

Additionally, some studies hypothesized that overweight and obese individuals have a higher preference for unhealthy foods, however, the results were not as straightforward as one might have expected (Adam Perl et al., 1998; Craeynest et al., 2005; S. Moore et al., 2022; Roefs & Jansen, 2002). Even though it seems that individuals with a higher BMI have a positive taste association with unhealthy foods so do the ones with a healthy BMI value (C. Hill et al., 2009). Conversely, overweight individuals tend to have a more negative attitude towards high-fat foods than those with a healthy weight (Adam Perl et al., 1998; Roefs & Jansen, 2002). Thus, liking the taste of unhealthy snacks doesn’t

necessarily mean that overweight people like the sugar, fat, or salt associated with these foods or that they don't desire healthy snacks. Even more, it has been revealed that overweight people prefer palatable healthy food to palatable unhealthy food (Craeynest et al., 2007). Hence, we hypothesize the following:

H3: BMI moderates the effect of snack type (healthy vs. unhealthy) on desire, in the way that individuals with a BMI above the healthy range, will show a stronger desire for healthy snacks than unhealthy snacks.

The food choices made by consumers are highly determined by their assumptions and preconceived expectations of that food (Furst et al., 1996). Often these are related to food aspects such as taste, convenience, or food processing level. Nevertheless, in the last years, health considerations of food have been gaining importance for consumers. Thus, healthiness is also one main characteristic influencing people's opinion on food products and thereupon, influencing their eating decisions (Alcaire et al., 2021; Grunert, 2006). Subsequently, it is important to understand how consumers evaluate the healthiness of snacks and investigate possible cues that can help design more appealing healthy snacks.

For example, the same study from König & Renner (2018) disclosed that in their experiment, encouraging the participants to eat colorful meals led to the consumption of healthier foods. Additionally, participants ate more vegetables and less sugary foods when the perceived color variety of the meals was higher. In a more recent study, König investigated if this effect was also true for more meal types and the results showed that color variety was also negatively associated with the consumption of unhealthy snacks (König et al., 2021). Thus, sustaining the positive association between eating colorfully and eating healthily. Another study investigated how people perceived the healthiness of soft drinks and concluded that drinks containing fruit were rated to be healthier, while drinks containing sugar content or additives were associated to be unhealthy (Bucher & Siegrist, 2015). This is most certainly because most people find additives to be unnatural and are afraid of the risks, they can add to their health (Bearth et al., 2014). Proving that the "naturalness" of food, is also an important factor in consumers eating choices, as artificial-looking food can be perceived as unhealthier. Hence, if we take a closer look at the unhealthy snacks available today, in many cases the different colors of the product either within the same brand or between brands, have no relation to the flavor of the food. See M&M's for instance, even if the chocolate pieces are sold in various colors, they all taste the same. Thus, one might assume that such foods that contain a range of different colors (different from their original color or the one expected) are coming from artificial color additives or added sugars and consequently are less natural and less healthy. Formally, we hypothesize that:

H4a: Multi-colored healthy snacks will be perceived as healthier than single-colored healthy snacks.

H4b: Multi-colored unhealthy snacks will be perceived as more unhealthy than single-colored unhealthy snacks.

2.5. OVERVIEW OF THE PRESENT RESEARCH

The focus of the present study was to examine the influence of high color variety (vs. low color variety) on the perceived taste, desire, and healthiness of healthy and unhealthy snacks. Based on previous literature, we tested the hypothesis depicted previously. We argue that snacks with high-color variety are more appealing, impacting positively consumers' taste perceptions. Moreover, we reason that the presence of high-color variety is associated with a higher desire for healthy snacks, but that it doesn't affect the desirability of unhealthy snacks. We also propose that BMI moderates the effect of snack type (healthy vs. unhealthy) on the desire to eat, mainly we suggest that individuals above the healthy BMI range, will show a greater desire for healthy snacks (compared to unhealthy snacks). Finally, we propose that the perceived healthiness of healthy snacks is positively impacted by color variety whereas it negatively impacts the perceived healthiness of unhealthy snacks.

3. METHOD

3.1. STIMULI AND PRETEST

A pretest was run to identify if there were any problems with unclear wording and to evaluate the fitness of the stimuli (e.g., if the snacks in the images presented were recognizable). The online questionnaire was done by 77 adult participants, where 62 were men and the overall mean age was 35 years old (range: 19-69). The questionnaire was distributed on MTurk and all the participants provided their informed consent and answered all the questions presented.

For this experiment, the two types of snacks chosen (apples and M&M's) were carefully selected. First, we selected products that consumers can easily recognize and identify if presented to them, even if observed through a simple image. Secondly, to evaluate the effect of color variety, we wanted to showcase snacks that already contain different colors (either naturally or artificially) but that did not have additional artificial coloring to meet consumers' expectations, since a different food color than the expected, can have a negative impact on its acceptance (Christensen, 1985; DuBose et al., 1980).

Furthermore, we aimed to test the previously specified hypothesis on snacks that are often eaten and wanted by consumers. Since chocolate and fruit were found to be the most sought-after snacks around the world (Nielsen, 2014), we chose one snack in each of those food categories. To validate the perception of the healthiness of both snacks, we ran a pretest to ask respondents to answer to what extent they considered the snacks (apples, M&M's, carrots, and chips) healthy on a 7-point scale. As expected, apples were considered healthier than M&M's ($SE = 0.46$, $t = -3.20$, $p = 0.002$). Specifically, the apple snack was rated as healthy ($M = 6.22$) while M&M's were rated as unhealthy ($M = 2.97$), which meets the information from the 2020 DGA.

Additionally, to confirm that the color variety manipulation was being met, participants were presented with a 7-point scale and had to rate 2 questions measuring the perceived color variety which included: "The snack in the image is colorful" and "The snack in the image has color variety". Multi-colored snacks were perceived as having more color variety ($F(1, 73) = 31.37$, $p < 0.001$), namely: Yellow M&M's were judged to be less colorful ($M = 4.22$, $SD = 0.31$) compared to multi-color M&M's ($M = 6.34$, $SD = 0.31$) and the three-colored apple snack was rated as more colorful ($M = 5.63$, $SD = 0.31$) than the yellow apple snack ($M = 4.36$, $SD = 0.29$).

The results from the pretest were useful to understand that there were in fact some problems with unclear wording, image recognition, and frequency distribution of some variables. Regarding the stimuli, for example, we noticed that the image with the yellow M&M's was often not correctly identified by the respondents (see Appendix A). Some participants identified it instead as "mango" or "beads". This might have happened because people didn't immediately associate a yellow-colored snack with chocolate. Thus, improving the image or changing the color of the one-colored unhealthy snack was needed to correctly evaluate the effect of color variety.

In the pretest, we have also omitted the name of the snack presented in the images. Instead of stating the name of the specific snack in the description, we have just described them as "candy snack" in the unhealthy condition or "fruit snack" in the healthy condition. From the responses, we could see that this led participants to think the images contained either general sweets (in the unhealthy condition)

or other fruits than the presented one (in the healthy condition). To make it more straightforward for respondents to quickly identify the snack presented, we have changed this to detail the specific snack name in the description of the main study in the following way: “candy snack: M&M's” and “fruit snack: sliced apple”, respectively.

Moreover, the M&M's images in the pretest didn't contain the “m” letter as it often appears in some packages. For the main study, we have made changes so that the stimuli would include the letter “m” in the M&M's condition. For that, we chose a different package that contained smaller-sized M&M's. As for the healthy condition, the stimuli in the pretest were an apple sliced into three identical pieces. However, we realized later that the way the apples were put together and presented was not so practical or realistic for someone's routine, so we decided to present the sliced apples in smaller cubes instead, for the main study.

What's more, we aimed to analyze if the height and weight of the participants had some effect on the results, but since the measure units of these variables can be different depending on the country, the labeling of the question (centimeters and kilos) was not the most appropriate. We ended up with values that we cannot say for sure what the scale used by the participants was. Hence, in the main study, these two questions were restructured to allow participants to indicate the scale being used by them. Finally, it would be important to balance better the number of respondents for each gender, which did not happen in the pretest (80.5% were men). Thus, gender distribution was considered in the main study, as it can happen that each gender has a more specific behavior.

3.2. MAIN STUDY - PROCEDURE AND PARTICIPANTS

In order to understand the effect that color variety has on snacking choices, this experiment was developed in Qualtrics following a 2 (snack type: healthy vs. unhealthy) x 2 (color variety: low vs. high) between-subjects factorial design. In this study, respondents were randomly exposed to one of four different snacking images: one-color healthy snack (a sliced yellow apple, $N = 52$); multicolor healthy snack (sliced apple containing 3 colors: yellow, green, and red, $N = 49$); one-color unhealthy snack (yellow M&M's, $N = 52$); or a multicolor unhealthy snack (M&M's with six different colors, $N = 51$) (see Appendix C).

Across all conditions, participants read, “You will now be presented with a picture of a snack:” “M&M's” or “sliced apple”, depending on the respective snack presented, and were asked to take a careful look at the image and answer the next questions regarding it. Participants were then asked to answer several questions about their opinions and thoughts on the snack presented to them as well as some questions about their usual eating habits and health considerations. Finally, participants were asked to recall the snack presented at the beginning of the experiment and to provide demographic information. All conditions and measures collected are reported in the next chapters. All in all, the questionnaire aimed to gather more insights into consumers' perceptions of snacks and to better understand how they react to decision factors of consumption such as taste, healthiness, and desirability of the food.

The online questionnaire was answered by 204 adult participants, where 132 were women and the overall mean age was 24 years old (range: 18 – 53). The questionnaire was distributed to NOVA

University students and those who participated in the study, by answering the questionnaire, were given a partial course credit in return. Furthermore, all participants provided their informed consent and answered all the questions presented. After a careful analysis, we excluded those observations from participants who incorrectly answered our attention check question, which required them to identify the snack presented at the beginning of the survey. In the end, only one participant failed the attention check, thus being excluded from the analysis of this study.

3.3. MEASURES

Perceived tastiness was the first construct analyzed as a measure to evaluate how tasty the respondents perceived the snack they were exposed to. After conducting a reliability analysis, we were able to merge three variables as they were loading on the same factor and the Cronbach's Alpha was 0.92. Thus, this construct included the following statements: "The snack on the picture is tasty", "The snack on the picture is appetizing" and "The snack on the picture is delicious". Participants were prompted to rate this construct on a 7-point scale (where 1 was "strongly disagree" and 7 was "strongly agree").

Secondly, another construct included in the questionnaire was perceived healthiness. This construct aimed to help us understand the extent to which consumers perceive the snacks to be healthy or unhealthy when only presented with a snack image and not any additional information. For this purpose, we had two statements that were included on a 7-point scale: "The snack on the picture is healthy" and "The snack on the picture is great for my health" (Cronbach's Alpha was 0.985). Participants rated the extent to which they agreed or disagreed with those two sentences.

Desire was an equally relevant construct to be considered in the analysis, which measured the psychological motivation to eat the snack presented. Once again, we had more than one statement loading in the same factor and so we conducted a reliability analysis where we were able to include the following items to measure this construct: "I will most likely eat this snack in the near future", "Right now I am craving the snack on the picture" and "I desire the snack on the picture". Here the Cronbach's Alpha was 0.806 and the scale was as well from 1 to 7, where 1 was "strongly disagree" and 7 was "strongly agree".

Attractiveness and freshness were two other constructs to be analyzed and both were used to capture how participants respond to the appearance of the snacks in the images. To measure attractiveness, the questionnaire included the statement: "The snack I saw looks good". As for freshness, the participants were asked to rate the following sentence: "The snack I saw looks fresh". In both cases, participants were asked to rate from 1 (strongly disagree) to 7 (strongly agree).

Moreover, the perceived sweetness of snacks was also considered to understand to what extent respondents associated the presented snack with a sugary and sweet taste. Participants were presented with a 7-point scale containing the following items: "The snack I saw has a very sweet taste" and "The snack I saw has a very sugary taste" and asked to choose from 1- "Strongly Disagree" to 7- "Strongly Agree". These two items were merged into the variable "sweetness" since they were highly correlated and so measuring the same effect (Cronbach's Alpha was 0.815).

Since one of the manipulations checked in this study was color variety, we also had to access and validate the perception of participants regarding the color variety of the snacks presented. For that reason, participants were asked to indicate to what extent they agree with the following 2 statements: "The snack I saw is colorful" and "The snack I saw has color variety". These two items were loading on the same factor and thus measured together, as Cronbach's Alpha was high (0.91).

Furthermore, we also asked some more questions to acknowledge how hungry individuals felt prior to being presented with the stimuli, and how satiated they would feel after eating the snack shown to them. Additionally, depending on the image they were exposed to, respondents had to guess how many fruit slices or M&M's were presented to them, to measure any possible effect on perceived quantity and satiation. Thus, three more variables were considered in the analyses: hunger, satiation, and perceived amount. Hunger was assessed through a 7-point scale where 1 represented "Not hungry at all" and 7 - "Extremely hungry". Satiation was equally evaluated on a scale of 1- "Very hungry" to 7- "Extremely full". Perceived quantity, on the other hand, was presented with a slider scale that ranged from 0 to 200 in the unhealthy snack condition and from 0 to 30 in the healthy snack condition.

Lastly, snack frequency was assessed to understand how often respondents usually eat healthy and unhealthy snacks and consequently, analyze their snacking habits. We have also inquired about their opinion on the snack itself and how often they eat it. At the end of the questionnaire, we also added some items to evaluate how important health is for the individuals, which contained the following statements: "I often think about my health", "I consider my diet to be healthy", "Eating healthy is important for my well-being", "Health is the main factor when deciding what I eat" and "Health is one of the factors when deciding what I eat". The scale used was a 7-point Likert item. These five items were merged into the variable "Health consideration" since they were loading on the same factor and so measuring the same effect (Cronbach's Alpha = 0.845).

4. RESULTS

The analysis of the data from the main study was done using SPSS Statistics, through which we employed a series of analyses of variances (ANOVA) to evaluate if there were significant differences in the averages between the different groups.

Perceived Color Variety. Since the images used in the main study were somewhat different from the ones used in the pretest, we started by analyzing if the color variety manipulation was successful. The results show that there was no doubt in the perceived color variety in the images presented to participants as the interaction effect was significant ($F(1, 200) = 24.539, p < 0.001$). Multi-colored snacks were perceived as having more color variety, namely: brown M&M's were judged to be less colorful ($M = 1.82, SD = 0.16$) compared to multi-color M&M's ($M = 6.5, SD = 0.16$) and the multi-colored apple slices were rated as more colorful ($M = 6.24, SD = 0.16$) than the yellow apple slices ($M = 3.14, SD = 0.16$).

Perceived Tastiness. The mean ratings of the perceived tastiness were computed for both types of snacks presented to the participants. With the analyses performed, we can affirm that color type has a significant main effect on the perceived tastiness of the snacks ($F(1, 200) = 10.505, p = 0.001$) and so does snack type ($F(1, 200) = 9.573, p = 0.002$). However, the interaction effect between color type and snack type was not significant. As hypothesized, an ANOVA analysis revealed that subjects perceived the multi-colored M&M's ($M = 5.26, SD = 0.20$) as significantly tastier than the brown M&M's ($M = 4.65, SD = 0.20$). Similarly, the effect was also seen for the healthy snacks, as the multi-colored apple slices were also perceived to be tastier ($M = 4.68, SD = 0.21$) than the yellow apple slices ($M = 3.98, SD = 0.20$). Thus, these findings indicate that color variety positively impacts the individuals' taste perception of snacks, supporting hypothesis 1, that multi-colored healthy and unhealthy snacks are perceived to be tastier than single-colored snacks. Furthermore, even if the Body Mass Index (BMI) doesn't play a significant moderation role in perceived tastiness, using the PROCESS SPSS macro (v4.0; Model 2; Hayes) we have found significant differences on some levels. For instance, those participants whose weight is in a healthy range, perceive unhealthy snacks to be tastier than healthy snacks both when the snack contains low color variety ($M = 4.76$ vs $M = 3.85, p = 0.01$) and when it is high in color variety ($M = 5.38$ vs $M = 4.65, p = 0.04$). However, overweight people don't show significant differences in the perceived tastiness of healthy and unhealthy snacks.

Desire. Next, we evaluated the mean results of the dependent variable "desire", for both healthy and unhealthy snacks. The interaction effect between snack type and color type was not significant ($F(1, 200) = 1.477, p = 0.226$). Nevertheless, color type and snack type individually, have a significant main effect in the desire of snacks ($F(1, 200) = 7.529, p = 0.007$) and ($F(1, 200) = 5.916, p = 0.016$), respectively. The pairwise comparisons and the univariate tests helped to clarify that this statistical relevance was seen for healthy snacks ($F(1, 200) = 7.759, p = 0.006$) but no significant differences in the desirability of unhealthy snacks ($F(1, 200) = 1.180, p = 0.279$) was found. Hence our study shows, in support of hypothesis 2, that multi-color healthy snacks ($M = 5.02, SD = 0.26$) were more desired than single-color healthy snacks ($M = 4.02, SD = 0.25$), while color variety doesn't play a role in the desirability of unhealthy snacks. Although not predicted, it is important to emphasize that multi-color sliced apples were more desired ($M = 5.02, SD = 0.26$) than multi-colored M&M's ($M = 4.10, SD = 0.25$). Interestingly the results show the opposite effect of high-color variety in taste perception. Hence, while

individuals perceive unhealthy multi-color snacks to be tastier ($M = 5.26$, $SD = 0.20$) than healthy multi-color snacks ($M = 4.68$, $SD = 0.25$), there was a higher desire for multi-color healthy snacks.

Furthermore, a moderation analysis showed that the overall interaction between snack type and color type was not significant having Body Mass Index (BMI) as a moderator (PROCESS SPSS macro v4.0; Model 2; Hayes). Nevertheless, the interaction effect between BMI and snack type was significant ($SE = 0.79$, $t = -1.973$, $p = 0.05$) which implies that there is a significant moderation effect of BMI in the sense that for overweight people, there is a significant difference between the 2 conditions (healthy vs. unhealthy). These results corroborate hypothesis 3, since overweight people showed a higher desire for multicolor healthy snacks ($SE = 0.46$, $t = -3.20$, $p = 0.002$) than multicolor unhealthy snacks ($M = 5.18$ vs. $M = 3.71$). However, for those with a healthy weight range (BMI between 18.5 and 24.9), snack type doesn't play a role in people's desirability to eat those snacks. A marginally significant effect was also observed for the single-color snacks ($SE = 0.44$, $t = -1.72$, $p = 0.09$), in which individuals who are overweight, rated the single-color healthy snack as more desirable than the single-colored unhealthy snacks ($M = 4.08$ vs. $M = 3.33$).

For an accurate interpretation of the results above, we considered the height and weight of the participants to compute BMI as the weight in kilograms divided by their height in meters squared. According to official data, adults aged 18-65 with a BMI of 25.0 or more fit the overweight category, while a BMI between 18.5 and 24.9 meets the healthy range (*Body Mass Index (BMI) Calculator - Diabetes Canada*, n.d.).

Perceived Healthiness. Since the stimuli used in our study contained sliced apples and M&M's, which are snacks on opposite spectrums regarding caloric and nutritional content, the effect of snack type (healthy vs. unhealthy) on the perceived healthiness of these two foods were undoubtedly expected ($F(1, 200) = 2462.149$, $p < 0.001$). Yet, we have also observed a marginally significant effect on the color type ($F(1, 200) = 3.770$, $p = 0.054$) as well as a marginally significant effect on the interaction between the combined conditions color type and snack type ($F(1, 200) = 3.712$, $p = 0.055$). With these results, followed by an analysis of the univariate tests, we were able to identify that there is a significant difference in healthiness perception for the healthy snacks ($p = 0.007$), validating hypothesis 4(a) that multi-colored healthy snacks would be perceived as healthier than single-colored healthy snacks. This can also be seen through the differences in the mean values of participants' ratings on perceived healthiness, as multi-colored apple slices ($M = 6.827$, $SD = 0.104$) scored higher than the yellow apple slices ($M = 6.433$, $SD = 0.101$). Thereby, healthy snacks containing a higher variety in color were perceived to be healthier than those that lack color variety. On the other hand, multi-color M&M's scored very closely to the brown M&M's ($M = 1.578$, $SD = 0.102$ and $M = 1.577$, $SD = 0.101$), therefore it was not possible to validate hypothesis 4(b). The fact that there were no significant differences in the perceived healthiness of single and multicolor unhealthy snacks might be because individuals already associate all colors present in M&M's to be artificial coloring, including brown. We have later run moderations with age and gender which didn't give any significant results. Thus, we can conclude based on the data, that the results here reported applies to all people regardless of these demographical factors.

Our study focused on three main constructs: tastiness, desire, and healthiness of snacks. Nevertheless, we have also encountered additional significant findings for other relevant constructs that impact snacking choice. Thus, these findings will be described and explained below.

Attractiveness. We have obtained a significant main effect of color type on the attractiveness of snacks ($F(1, 200) = 20.649, p < 0.001$). By analyzing the univariate tests, we concluded that such an effect was both statistically relevant in the healthy ($F(1, 200) = 6.549, p = 0.011$) and unhealthy conditions ($F(1, 200) = 14.939, p < 0.01$). Participants determined that the colorful apple slices ($M = 5.673, SD = 0.194$) and multi-color M&M's ($M = 5.667, SD = 0.190$) looked more attractive than the single-color apple slices ($M = 4.981, SD = 0.188$) and brown M&M's ($M = 4.635, SD = 0.188$). Hence, color variety seems to positively impact the attractiveness of healthy and unhealthy snacks. By running a regression analysis with PROCESS SPSS macro (v4.0; Model 3; Hayes) we have additionally uncovered that there is a marginally significant interaction effect between snack type, color type, and BMI ($SE = 0.12, t = -1.74, p = 0.084$). In this case, snack type moderates the effect of BMI on how attractive individuals perceive single and multicolor healthy snacks to be. With this moderated moderation, we can conclude that those who are overweight (whose BMI is higher than the recommended values) consider healthy colorful snacks to look more attractive ($M = 5.88$) than single-color healthy snacks ($M = 4.37$). However, there are no significant differences in the attractiveness ratings of those participants with a healthy BMI range between multicolor healthy snacks and single-color healthy snacks ($M = 5.52$ and $M = 5.60$, respectively).

Freshness. An analysis of variance (ANOVA) on the perceived snack freshness revealed a significant main effect of color type ($F(1, 200) = 180.584, p < 0.001$) and snack type ($F(1, 200) = 23.416, p < 0.001$). Yet, there was a non-significant interaction effect between snack type and color type ($F(1, 200) = 0.252, p = 0.616$). Both healthy and unhealthy snacks high in color variety were rated to look fresher than those which contained one single color. The three-colored apple slices ($M = 6.347, SD = 0.208$) were considered to look fresher than the yellow apple slices ($M = 5.462, SD = 0.202$). Similarly, the multicolor M&M's ($M = 3.706, SD = 0.204$) were considered to look fresher than the one-color (brown) M&M's ($M = 2.615, SD = 0.202$).

Perceived Amount. Moreover, we verified if there were significant differences between the perceived amounts of candies and apple slices in the different color conditions. Since the stimuli in the healthy and unhealthy settings had different amounts of the respective snack (M&M's = 65, Apple slices = 19), we have analyzed if there were differences in these two types of snacks, separately. We have observed a statistically significant effect of color type on the perceived amount of the healthy snack ($F(1, 200) = 6.72, p = 0.011$) since participants believed the multicolor healthy snack to contain more apple slices ($M = 11.22, SD = 0.45$) than the single-color version ($M = 9.62, SD = 0.43$). Considering that in the actual stimuli presented, the container had 65 M&M's, on average participants believed the higher color variety setting to have more M&M's ($M = 62.75, SD = 4.77$) than in the single-color condition ($M = 52.73, SD = 4.72$), however, these differences were not significant ($F(1, 200) = 2.23, p = 0.138$).

Perceived Sweetness. Finally, a one-way ANOVA was performed to measure if there were significant differences between the perceived sweetness of colorful and single-color snacks. The data show that there was a significant effect on snack type ($F(1, 200) = 88.31, p < 0.001$) where unhealthy snacks were rated to be sweeter than healthy snacks, whereas neither color type nor the interaction between color and snack type appeared to be significant. Nevertheless, a moderation analysis (PROCESS SPSS macro v4.0; Model 3; Hayes) revealed a significant interaction effect between snack type, color type, and age ($SE = 0.056, t = -3.0, p = 0.003$). Thus, age acts as a significant moderator (moderated by snack type) to the perceived sweetness of snacks. Ultimately, this moderation effect of age strengthens the effect that color type has on the perceived sweetness of snacks since younger participants believe unhealthy

colorful snacks ($M = 6.15$) to taste sweeter than unhealthy single-color snacks ($M = 5.30$). However, the older participants manifested the opposite behavior, indicating that the taste of unhealthy single-color snacks ($M = 7.0$) seemed sweeter than the multicolored unhealthy snacks ($M = 4.88$). Conversely, no significant differences were witnessed in the perceived sweetness of healthy snacks.

5. GENERAL DISCUSSION

Many people consider that eating healthy food is important and beneficial to their well-being, showing intentions of pursuing a healthy diet (de Ridder, Kroese, et al., 2017). Nevertheless, consumers believe that one needs a lot of self-control to opt for healthy foods, as it is associated to be less pleasurable than unhealthy foods (Cornil & Chandon, 2016). To help people make snacking choices, based on their intentions of eating healthily, we need to find subtle ways to improve consumers' perceptions of healthy snacks. Thus, the present study investigated the effect of color variety on the perception of several factors that highly impact snacking choices, such as taste, desire, and healthiness. Consequently, we compared people's associations with healthy and unhealthy snacks containing high and low color variety to understand if this specific visual cue can lead to healthier snacking consumption.

In this study, we provide evidence that increasing color variety can be a good avenue to improve people's associations with healthy snacks. Mainly, we demonstrate that color variety positively impacts individuals' taste perception for healthy and unhealthy snacks, since multicolor snacks were associated with being tastier. Results also revealed that increased color variety was associated with an increased desire for healthy snacks, more so than unhealthy snacks for those individuals over the healthy weight range. Furthermore, healthy snacks are perceived to be healthier when containing color variety. Thus, providing support for the hypotheses 1, 2, 3 and 4a. In the next chapters, we will discuss in detail the theoretical and practical contributions of these results as well as introduce the limitations of this study and provide suggestions for future research.

5.1. THEORETICAL CONTRIBUTIONS

The unfortunate reality is that most people still don't consume enough fruits and vegetables (Hall et al., 2009) and overconsume fat and sugary foods (World Health Organization., 2007). Consequently, there has been a crescent effort, from several entities and governments to provide consumers with public initiatives to promote healthy eating habits and change this course of action. From diet and educational programs on dietary practices to marketing campaigns, most of those measures tend to fail on creating a positive long-term effect on consumers' food choices (Carins & Bogomolova, 2021; de Ridder, Evers, et al., 2017; Walls et al., 2011). What these attempts have in common is that they all are explicit strategies, which have unveiled much poorer results in improving dietary habits compared to implicit techniques. Therefore, applying food cues, for example, is a more efficient approach to direct people towards healthier eating habits, while being more accepted, due to its subtle nature (Irmak et al., 2011; Privitera & Creary, 2012). With that in mind, the present research contributes to the existing literature by providing an additional way that might ease healthier snacking consumption through color variety. To the best of our knowledge, this work is the first to entail the relationship between intrinsic color variety and perceptions of taste, desire, and healthiness of healthy and unhealthy snacks, filling the gap in this research area.

Previous research has disclosed that taste is a factor of extreme importance in food decisions, while unhealthy snacks are often associated as tastier (Kourouniotis et al., 2016; Raghunathan et al., 2018).

Our findings are consistent with the existing literature, indicating that in fact, unhealthy snacks are perceived to be tastier than healthy snacks for most people. However, the overweight people in our sample didn't show significant differences in the perceived tastiness between healthy and unhealthy snacks, revealing that they find both snacks (apple slices and M&M's) similarly tasty. Plus, we have additionally uncovered that color variety increases both the tastiness association of healthy and unhealthy snacks when compared to no or few color variety. Consequently, by examining the role that color variety plays in perceived tastiness, we provide new evidence that the lack of tastiness associated with healthy snacks can be tackled by the presence of color variety. Thus, providing healthy colorful snack options might be just what consumers need to instinctively make healthier snacking choices.

Moreover, with the present research, we found no evidence that color variety influences the degree to which people desire unhealthy snacks. Conversely, and similarly to the effect of color variety on taste perception, individuals show a higher desire for healthy snacks that contain a range of different colors, compared to snacks that are low in color variety. Meaning that consumers' craving and desire for healthy snacks are enhanced by color variety. What's more, we demonstrate that color variety is an effective way to shift craving and desire toward healthier snacks, specifically for overweight people, since these individuals showed stronger intentions to eat multi-colored healthy snacks than unhealthy snacks. This suggests that even if consumers tend to assume a tasty flavor from unhealthy snacks, taste alone doesn't stop people from finding healthy snacks more desirable. This adds a different perspective to the existing literature since until now, research has linked foods involving elevated sugar, salt, and fat with a higher desire and craving. In particular, several studies refer chocolate to be the most craved food in Western culture (Meule, 2020; Richard et al., 2017; Rozin et al., 1991; Schumacher et al., 2017; Weingarten & Elston, 1991). Thus, our findings not only show that color variety has a great influence on the desirability of healthy snacks, but we provide evidence that chocolate and unhealthy snacks aren't necessarily more desired than healthy snacks if those foods include color variety.

Despite the work done on understanding associations between color variety and eating healthily, there is still a lack of research and information on this topic. For instance, a positive association between eating colorfully and eating healthily has been revealed (König et al., 2021; König & Renner, 2018, 2019) but the consumers' perceptions of healthiness have not been addressed. Thus, our experiment extends previous work, by corroborating that color variety also influences the perception that people have of the healthiness of healthy snacks. Specifically, we can conclude that color variety induces a belief that healthy snacks are not as healthy as their multi-colored version. Thus, sustaining the positive association between color variety and perceived healthiness. Moreover, existing literature has reasoned that the absence of additives in food is perceived positively and is linked to healthiness. On the opposite end, unnatural foods, including those with color additives, leans consumers to think about health risks and consequently, create unhealthy associations (Bearth et al., 2014; Bredahl, 1999). Interestingly, there is no evidence that color variety impacts the perceived healthiness of unhealthy snacks. One possible reason that might have led to no differences in perceived healthiness of unhealthy snacks, might be then because the snack used in our study is commercialized as multi-colored round-shaped chocolate where its content only differs in its candy shell colors. Thus, even though our tested single-color was brown, which is the commonly expected color for chocolate, individuals may already associate M&M's, regardless of their color, to contain artificial coloring and added sugars, thus being perceived as equally unhealthy.

The findings of this work also suggest that multi-colored unhealthy snacks send a more attractive appeal to individuals than single-colored unhealthy snacks. This is coherent with previous literature that found that foods with contrasting colors are associated with higher complexity and attractiveness, while the lack of color contrast can be linked to boredom and less appealing (Mielby et al., 2012; Paakki et al., 2019). Additionally, by examining the moderation role of Body Mass Index, we substantiate that this effect of color variety on the attractiveness feel of healthy snacks applies to people with higher BMIs (overweight) while no evidence is found for those within a healthy BMI range. Thus, validating that the presence of color variety can too, influence the attractiveness of snacks. Similarly, studies have shown that color influences perceived sweetness (Lavin & Lawless, 1998; Pangborn, 1960), and those contrasty colors can enhance the perceived sweetness of food (Piqueras-Fiszman et al., 2012). Our results, however, add to the existing literature by providing evidence that the impact of color variety on sweetness perceptions, is not as straightforward, at least not in the snack category. First, we found no evidence that color variety influences the perceived sweetness of healthy snacks. Secondly, sweetness perceptions of unhealthy colorful and single-colored snacks differ depending on consumers' age since young adults believe unhealthy colorful snacks to taste sweeter, while older people have the opposite opinion, finding single-color unhealthy snacks to be sweeter.

Furthermore, the term "fresh" has been shown to be highly associated with healthy foods (Kombanda et al., 2022) and in line with this, our results show that healthy snacks are considered fresher than unhealthy snacks. In addition, we have achieved similar conclusions to previous literature about the influence of color variety on the perceived freshness of food, in the way that freshness perceptions are negatively associated with the absence of color variety (Paakki et al., 2019). Interestingly, we add that this association also happens in unhealthy snacks, meaning that individuals believe varicolored unhealthy snacks to look fresher than the same snack lacking color variety, even if there are no differences in their real freshness. Finally, while it has been previously suggested that color variety reduces perceived quantity (Redden & Hoch, 2009) in our study, we couldn't find any evidence of this effect on the perceived number of unhealthy snacks. Furthermore, and contrary to the literature, our findings show that multicolored healthy snacks are thought to contain bigger quantities than their single-color version.

5.2. PRACTICAL IMPLICATIONS

Notably, the findings of this study provide several theoretical contributions. However, it is equally important to understand their implications in practical terms and how they can benefit consumers, governments, and both the health and food industries, for example. First, unhealthy snacking has an important role in obesity and consequent health issues, therefore, it is important to find new avenues to change this snacking behavior into a healthier one. As it has been studied, even if consumers believe healthy snacks to be better for their health and wellbeing than unhealthy snacks, the temptation frequently associated with the taste and desire for indulgent food, leads them towards unhealthy choices. This happens because most people don't find healthy snacks an indulgent choice, they rather associate healthy snacks with what they should eat, and not what they actually crave eating (Cornil & Chandon, 2016). Nevertheless, healthy snacks are still mostly marketed as healthy, even if people many times resort to snacking to fulfill hedonic hunger. For that reason, understanding more subtle

ways of changing people's snacking choices may be the key to accelerating healthy eating habits (Heymsfield & Wadden, 2017; Nielsen et al., 2002).

This research provides new possibilities on how to lead consumers towards healthier snacks, keeping their independence of choice intact and not forcing any thinking on health facts, which tends to negatively impact consumers' eating experience (Schlinkert et al., 2020). Given that high-color variety increases the individuals' taste perception and desire for healthy snacks, decision-makers in the food industry should aspire to provide more appealing healthy snacks by enhancing the color variety of the food items. In the same line of thought, instead of focusing on the health proprieties of snacks, marketers should embrace the positive effect of color variety on consumers' perceptions and use it to advertise healthy snacks as attractive and tasty instead. Thus, our findings on the influence of color variety on the perceived taste and desire of snacks, provide an alternative way for companies to market healthy snacks to consumers. Moreover, since there is evidence that multicolored healthy snacks are also perceived as healthier than otherwise single-colored, it might create a win-win effect, in the sense that it can also allure those consumers already seeking healthy options. Ultimately, this might help increase sales and grow the return on investment from marketing efforts of healthy snack brands.

Importantly, this research addresses an additional way to accelerate consumers' general health by improving the perceptions that people have of healthy snacks and consequently, facilitating a shift to healthier snacking habits. The analysis presented in this study identifies then a more natural and intuitive strategy that health organizations and governments can offer to promote better food choices. For once, persuading patients to snack healthily might be easier for public health entities if more multicolored healthy snack options are available in the market. Additionally, encouraging to snack colorfully can be a good strategy to increase the desire for healthier diets with a variety of nutrients that meet health recommendations, even more for overweight people, since they respond very positively to the cue of color variety. Hence, promoting healthy snacks with evident color variety can be a more successful and cost-effective avenue to reduce unhealthy snacks consumption and obesity in the population, while mitigating the health problems that occur from there. Notably, reducing subsequent health problems from unhealthy eating will not only improve people's health and well-being but will as well relieve the pressure from hospitals and medical centers while lowering health expenditures. Hence, governments should create incentives and policies to make it easier for this type of healthy snacks to be produced and commercialized. Overall, this study fosters new opportunities for companies and health organizations to reduce unhealthy snack consumption and potentially decrease negative health consequences from it.

5.3. LIMITATIONS AND FUTURE RESEARCH

As previously mentioned, this work provides important theoretical and practical contributions. Notwithstanding, we recognize that there were some limitations that deserve to be further investigated and considered in future research. For a start, future work should consider including a higher number of participants, to draw conclusions from a bigger sample. For instance, one evident limitation of the sample of this study was the lack of variety of cultures and ages, since most participants were young Portuguese university students. Especially because previous research has

shown that cultural influences and differences play a big role in how people perceive food and snacking (Werle et al., 2013). Consequently, our results may not apply to other populations with different cultural food beliefs or associations. Thus, further research could evaluate if the reported consumer behaviors in this study also apply to older generations, other nationalities, and/or even to individuals with different educational backgrounds. In short, a larger sample with a higher demographic variety could provide additional support to the several hypotheses depicted in our analysis.

The present study is also limited to only two different snacks (M&M's and apples) and whereas different colors could have taken place for the single-color conditions, our research focused only on one color for each snack type: yellow for the apple snack, and brown for the M&M's snack. Hence, something that can possibly extend and improve this research, is to further evaluate consumers' perceptions of the different possible colors of the same two snacks used in our study. A different selection of snacks containing different colors (e.g., potato chips, cereal bars, etc.) could also be considered in future research to test the generalizability of our results.

In our study, the participants' perceptions were assessed through an online questionnaire which allowed us to analyze their responses and make conclusions based on their intentions and beliefs. However, these findings are limited to consumers' perceptions and intentions and do not allow us to draw conclusions on what would their actual behavior be when prompted to eat or purchase these snacks. Thus, assessing individuals in an in-person context (e.g., laboratory or field experiment) could be an interesting step to warrant conclusions on the effects of color variety on actual snacking behaviors.

Moreover, there is no certainty for the reason why our results contradict previous literature on perceived food quantity. One possible explanation might be that color variety has a different effect on the perceived amount of healthy snacks. However, even if we tried to provide the most similar images of both snack versions, they were not 100% identical, which might have impacted perceived quantities. Plus, our study was developed online, which might lead to different results compared to when people have access to real observation of food. Hence, a possible next step could be to investigate how color variety impacts the perceived quantity of food and its effect on the different food products.

Finally, our suggested model was carefully built by selecting variables that, according to previous literature, are important to consumers' snacking choices. Nevertheless, it is possible that other variables not considered in our study, such as additional people's eating habits, lifestyle, mood, work status, and the number of children in the household, can too be important. Therefore, one may consider extending our research and proposed model by examining other possible moderators or constructs that might impact consumers' snacking perceptions and choices. Despite these limitations, this study makes significant contributions, described previously, to understanding the impact of color variety as a visual cue in consumers' perceptions of taste, desire, and healthiness.

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7. APPENDICES

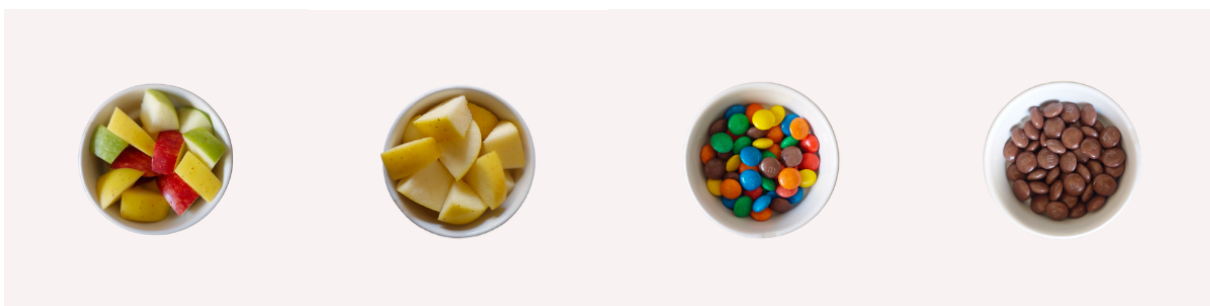
APPENDIX A: IMAGES DISPLAYED TO PARTICIPANTS IN THE PRETEST SURVEY



APPENDIX B: MEASUREMENTS, AND SCALES OF PRETEST SURVEY

Constructs	Measurement Items	Scale
	<p>Q: "Please indicate your level of agreement for each of the following statements on a scale from 1 to 7, where 1 represents "Strongly Disagree" and 7 "Strongly Agree"."</p>	
Tastiness	<p>The snack in the picture looks tasty. The snack in the picture is appetizing.</p>	(7-point scale: 1= "Strongly Disagree"; 7= "Strongly Agree")
Healthiness	<p>The snack in the picture is healthy. The snack in the picture is a great choice for a healthy diet.</p>	
Desire	<p>I will most likely eat this snack in the near future. Right now I am craving for the snack in the picture.</p>	
Sweetness	<p>The taste of the snack presented is very sweet. The snack presented has a very sugary taste.</p>	
Attractiveness	<p>The snack in the image looks good. The snack in the image looks fresh.</p>	
Colorful	<p>The snack in the image is colorful. The snack in the image has color variety.</p>	

APPENDIX C: IMAGES DISPLAYED TO PARTICIPANTS IN THE MAIN SURVEY



APPENDIX D: MEASUREMENTS, AND SCALES OF THE MAIN STUDY SURVEY

Construct	Measurement Items	Scale
Hungriness	On a scale from 1 to 7, where 1 represents "Not at all hungry" and 7 "Extremely hungry", how hungry do you feel right now?	7-point scale: 1 = "Not at all hungry" 7 = "Extremely hungry"
Perceived Amount	Please guess how many candies/fruit slices were in the bowl.	Slider scale: candies range = 0-200 fruit slices range= 0-30
Perceived Taste	Please indicate your level of agreement for each of the following statements on a scale from 1 to 7, where 1 represents "Strongly Disagree" and 7 "Strongly Agree". The snack on the picture is tasty ... appetizing ... delicious	7-point scale: 1 = "Strongly Disagree" 7 = "Strongly Agree"
Perceived Healthiness	Please indicate your level of agreement for each of the following statements on a scale from 1 to 7, where 1 represents "Strongly Disagree" and 7 "Strongly Agree". The snack on the picture is healthy ... great for my health	7-point scale: 1 = "Strongly Disagree" 7 = "Strongly Agree"
Desire	Right now I am craving the snack on the picture. I desire the snack on the picture. I will most likely eat this snack in the near future.	7-point scale: 1 = "Strongly Disagree" 7 = "Strongly Agree"
Attractiveness	Please indicate your level of agreement for each of the following statements. The snack I saw Looks good.	7-point scale: 1 = "Strongly Disagree" 7 = "Strongly Agree"
Freshness	Please indicate your level of agreement for each of the following statements. The snack I saw Looks fresh.	7-point scale: 1 = "Strongly Disagree" 7 = "Strongly Agree"
Perceived Sweetness	Please indicate your level of agreement for each of the following statements. The snack I saw Has a very sweet taste. ... Has a very sugary taste.	7-point scale: 1 = "Strongly Disagree" 7 = "Strongly Agree"
Color variety	Please indicate your level of agreement for each of the following statements. The snack I saw Is colorful. ... Has color variety.	7-point scale: 1 = "Strongly Disagree" 7 = "Strongly Agree"
Satiation	On a scale from 1 to 7, where 1 represents "Very hungry" and 7 "Very full", how satiated would you feel if you ate this entire bowl of snack?	7-point scale: 1 = "Strongly Disagree" 7 = "Strongly Agree"