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ORIGINAL ARTICLE

The role of cognitive processes in healthy consumption food products: An eye-tracking technology study

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Abstract

This research investigates consumer behavior when selecting snacks and beverages from vending machines in educational settings. The study aims to discern the impact of age on decision-making processes, perceptions, and memory factors related to product choices. Three experiments involved eye-tracking technology to monitor visual attention and a questionnaire to gather additional insights. The experiments analyzed the number of fixations, perceptions, overall product impressions, and memory influence. The sample comprised 90 adults aged 18 to 65 from the Pontificia Universidad Javeriana Cali. This sample includes a population distribution of 60% women and 40% men. Additionally, the socioeconomic distribution across economic levels was reported as follows: 40% falling within levels 1, 2, and 3, and 10% within levels 4, 5, and 6. The experiments revealed age-related differences in consumer behavior. Older individuals placed greater emphasis on healthier beverages, whereas young-adult individuals favored healthier snacks. Perception differences existed between age groups for beverages and snacks. Young-adult participants exhibited stronger positive perceptions of somewhat healthy options. Memory influenced choices, with young-adult participants relying more on memory cues. The findings provide valuable insights for tailoring marketing strategies and enhancing public policy initiatives to promote healthier vending machine choices.

Keywords Eye-tracking technology · Healthy consumption · Cognitive processes

Introduction

The rising global prevalence of overweight and obesity presents a critical challenge to the sustainability of healthcare systems worldwide, with significant implications for European health. In response, public policies and initiatives have increasingly centered around combatting this multifaceted nutrition issue by emphasizing diet and physical activity interventions. Within this landscape, innovative projects have been encouraged by entities like the European Commission, supported by organizations such as the Consumers, Health, Agriculture, and Food Executive's Agency, continuously providing calls for proposals and grants to bolster health-focused programs (European Commission 2023). Of particular note is the recent shift toward prioritizing vulnerable segments, including children, pregnant and lactating women, and the elderly.

The literature underscores seven fundamental intervention domains that public policies should address, encompassing knowledge, attitudes, behavior, dietary habits, and preventive indicators (World Health Organization 2023). Aiming to align with these recommendations, research efforts in healthy nutrition have highlighted various areas of interest. These encompass advanced technologies such as eye-tracking (Neuhofer et al. 2023; Rantala et al. 2022; Delivett et al. 2022; Zhou et al. 2022; Gabor et al. 2020a, b;), consumer intentions (Moore et al. 2022), dietary lifestyles (Gaeini et al. 2023; Imron et al. 2023; Kelleher et al. 2023; Shaw et al. 2023; Khadem et al. 2023; Pan et al. 2023), policy analyses (Sy et al. 2023; Pomeranz et al. 2023; Rahman

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et al. 2023), and the impact of dietary nutrients (Chong et al. 2023; James et al. 2023; Silva et al. 2023; Tekin et al. 2023; Garg et al. 2023; Speciani et al. 2023).

Considering the previous studies, the research question is related to the need to analyze the behaviors of the intake of healthy foods in educational contexts such as higher education institutions. In the midst of this dynamic research landscape, two critical gaps emerge. Firstly, the underexplored areas of signaling and behavioral choice theories still need to be utilized despite their potential for shaping effective interventions (Abdullah et al. 2022; Imron et al. 2023). For the specific case of studies that consider signaling an essential element to understand behaviors and responses to different signs, the young-adult population, especially the context in which they interact, becomes highly important for the academic field of consumer behavior. Secondly, a notable need exists for studies examining the efficacy of different dietary behaviors, particularly within educational contexts (Imron et al. 2023). This last aspect is directly related to the need to improve spaces for interaction, especially concerning healthy consumption in an educational context, a matter of great importance today. This is due to the many obesity problems in the young-adult population.

This study addresses these research gaps by delving into cognitive processes encompassing perception, memory, language, and decision-making when consumers opt for healthy food products from vending machines. To outline the paper's structure, we will begin with an overview of relevant literature, specifically focusing on brand signaling and behavioral choice theories. Subsequently, the research methodology and experimental design will be detailed. The presentation of our findings, extracted from information processing, will ensue. Finally, the paper will conclude by highlighting its empirical and academic contributions, ultimately shedding light on consumer behavior dynamics in healthy food choices within vending machine contexts. Through this investigation, we aspire to enhance our understanding of consumer preferences and decision-making mechanisms, thereby contributing to developing effective public policies and interventions in healthy nutrition.

Theoretical framework

Emotional and cognitive processes in eye-tracking research

Studies related to emotional and cognitive processes that determine specific human behavior demand an approach from which it is possible to understand the different results obtained. These previous ideas are how scholars such as Subramaniam et al. (2023) determine that different modalities have been used to analyze the physiological and attitudinal responses, such as electroencephalography, electrothermal activity, and electrocardiograms.

Despite the research on ocular physiology and its response to emotional and cognitive factors, this approach provides essential elements for understanding cognitive functions and their relationship with the affective state (Burley et al. 2017). In recent years, a growing interest in the relationship between cognitive and emotional can be perceived. These investigations have shown themselves to be fundamentally based on the fields of neurophysiology that have allowed the analysis of behavior patterns in a neural network.

Other approaches study physiological and physical responses, trying to find relationships between behaviors and responses obtained measured through biometric factors (Eckstein et al. 2017). Considering the developments in the field, using tools such as eye-tracking has allowed us to deepen the study of behaviors and emotions and how eye movements are monitored in real-time, adding new techniques for processing data. The data create an essential variety of algorithms that allow the creation of suitable metrics to identify behaviors through the movements of the eyes.

According to scholars such as Wang et al. (2018), tracking technology allows for analyzing eye movements, facial expressions, and everything associated with signals immersed in behavioral motivations. In this way, facial expressions have emotions integrated into behavioral signals. In this way, the value of the signal, the ocular movement, and the easy expressions will allow a better apprehension of the individual perceptions and the emotions linked to it. In this way, the so-called Signaling theory is one of the approaches that allow giving fields of action to study the signals of behaviors and emotions.

Signaling theory

Most attention is paid to different studies about how signs can influence how reality is perceived. These perceptions are related to the information asymmetry in the parties involved. They can lead to developing different behaviors that commit to specific objectives (Connelly et al. 2011). The brand signaling theory has been used in different studies ranging from anthropology to management (Smith et al. 2005). Other authors have identified how, in work settings, the employees of a company can develop a level of distinction among other employees in terms of quality by the symbol of their professional training (Spence 1978).

In the same way, the signaling theory allows us to understand the influence of symbols on acquired behavior, especially in a context characterized by food intake through the different products available in higher education institutions (Connelly et al. 2011; Spence 1978). The preceding goes hand in hand with the objective of this research regarding the analysis of behaviors in the intake of healthy foods in

educational contexts. An important aspect to highlight is that food intake is subject to its promotional aspects while using symbols becomes a means of promoting consumption, to which people can respond (Abdullah et al. 2022).

In this way, it is possible to find in the literature how the signaling theory has been used in studies on how signs interact with their contexts and how significates are developed. Despite the above, the brand signaling theory still requires verification at a conceptual level related to its different vital concepts and its understanding in the empirical field. The preceding is based on authors such as Highhouse et al. (2007), who argue that on some occasions, there is talk of a poor definition of the theory where its key elements still need to be more diffuse. From fields such as management and the inclusion of fields such as consumer psychology, there has been engagement in continuing to describe signaling theory systematically and its applicability in research (Highhouse et al. 2007).

According to Astrachan et al. (2018), the signaling theory can be considered based on four pillars: signaler, signal, receiver, and feedback. As a result of this research, it has been possible to identify that the definition of the Brabin is an autonomous construct in which identity is an antecedent and reputation has a consequence that affects a specific behavior (Abdullah et al. 2022). Considering the above, the brand signaling theory allows us to analyze a consumer's identification concerning the credibility that a brand produces and the trust toward it.

From the above, it can be concluded that this identification process is associated with communicating commitments and organizational strategies that consumers symbolize (Spry et al. 2011). In this way, through the consumer's symbolization, they evaluate a brand's informational content; simultaneously, it allows them to identify its credibility. For authors such as Skiba et al. (2019), credibility and trust in a consumer can favorably influence the development of favorable behavior, reducing the possibility of suspicion and generating beneficial actions.

On the other hand, authors such as Abdullah et al. (2022) state that consumers consider credibility as a psychological phenomenon that stimulates a consumer's buying instinct. Studies such as those by scholars such as Konuk (2018) have found that brand credibility predicts the result of behavior in consumer satisfaction and, in turn, in the purchase decision. Despite the above, there is still the possibility of risk in communication that can lead to conditions that put consumer perception at risk and lead them to make more conscious decisions about food selection and innovative products.

Scholars such as Spry et al. (2011) state that psychological theories have stated that individuals are influenced by the information given by a finished product and consider the source of information. This information is processed and includes the evaluation of the brand's credibility, which helps reduce the level of uncertainty of the consumer. In this way, food consumers require greater trust in the brand and a developed reputation to stimulate healthy food consumption. In this way, the perception of high credibility in the brand will generate a greater inclination toward purchasing healthy products.

Healthy foods are related to the number of nutritional factors in the food; likewise, everything related to calories, nutrients, and especially the amounts of sugar in the products (Chan & Zhang 2022; Mendonça et al. 2016). On the other hand, in virtual reality, its evaluation contemplates a series of difficulties at the individual level. These range from information on the products' nutritional status to making decision-making processes subjective and based exclusively on intuition (Rodier et al. 2017; Barthes 2018; Ruíz-Roso et al. 2020). The preceding has led to observing behavior patterns determined by the context, especially the interest in organic foods that do not have chemical substances and are free of additives (Lazaroiu et al. 2019; Yee et al. 2017).

The problem of the information provided by a product, and more specifically in what influences consumer perceptions, continues to attract the attention, especially of researchers in healthy nutrition. Such is the case of nutrition labeling, which is part of the actions undertaken in various countries to help consumers improve their eating environments, which Favor better healthy options (Cecchini et al. 2016). In this way, numerous studies have been conducted to understand consumers' purchasing decisions when exposed to the information provided in the products (Jáuregui et al. 2020).

Although some studies have shown that nutritional information does not affect purchasing decisions, it has been possible to identify that consumer understanding has a mediation effect, especially when choosing products with high quality and healthy nutritional content (Grunert et al. 2007). The previous goes hand in hand with the objective of this research as long as it is possible to identify the behaviors associated with food intake characterized by behavioral responses to the different signs used in food promotion. For Scholars such as Jáuregui et al. (2020), the actions taken by governments in Latin America to manage labels on non-saleable nutritional contents due to the high amounts of saturated fat, added sugars, and salt have had to manage several symbols that indicate unhealthy content as consumption warnings.

These actions tend to improve behavioral attitudes regarding consumer choices. These behavioral tendencies have been verified in different studies, especially generating the propensity to consume healthily since, in most cases, consumers are unaware of the high content of unhealthy factors in what they consume (Chen et al. 2020). Additionally, it has been found that adults tend to omit the amounts of sugar in their evaluations, both in drinks and in snacks, when there

is no educational environment that allows them to become aware of the type of products they consume (Chien et al. 2018; Chen et al. 2019).

For scholars like Qian et al. (2023), the shapes of the symbols used in the products' images influence the consumers' habits. The study on male consumption habits found that the signs of masculine forms can influence men to adopt healthy behavior patterns more significantly than other population segments. Additionally, other studies, such as those by Otterbring et al. (2018), found new patterns of behavior derived from consumer purchases, such as products with a high content of symbols, especially among segments of men and women and in specific age ranges.

According to Diouf et al. (2023), the diverse types of advertising firms used to sell products have different persuasion levels. In studies on different product categories, primarily beverages and snacks, consumer perception is influenced by the stimuli presented by product brands in a differentiated way between young adults and older people. This previous condition shows the need to analyze the cognitive processes of persuasion that arise, especially in populations with age variations. Thus, the following hypothesis is posited:

Hypothesis 1 When consumers choose a beverage, perception influences young-adult people more than older people.

Hypothesis 2 When consumers choose a snack, perception influences young-adult than older people.

In studies developed by Lo et al. (2017), it was determined that menu items, in the case of beverages, affect consumer behavior, especially quality perceptions and the service experience. Regarding the provision of nutritional information on the product, there may be an improvement in the knowledge of sustainability activities that allow those who consume a better understanding of the product and better communication of the characteristics of the product by the product. In this way, product design becomes a vital tool to communicate the product's benefits effectively and express the product's healthiness, especially in snacks and beverages (Lassen et al. 2016).

According to McNeill et al. (2017), in using tools such as eye-tracking, few studies have evaluated the prevalence of behavior in consuming a product between age differences. Despite the above, the literature in the field raises numerous studies that, despite having evaluated the perceptions that consider quality, flavor, and perception of healthiness, have yet to have significant results either. In the same way, other studies in the field have found variations in the influences on the color of the packages that have sometimes shown a certain degree of influence on the perception of what is healthy. Considering the mix of variations in the results of the studies, it has been found that the design of the product packages has a certain level of influence on the perceptions of quality and flavor (Sandberg et al. 2010). Thus, the following hypotheses are proposed:

Hypothesis 3 When consumers choose a beverage, the overall product perception (quality, flavor, and healthy perception) influences young-adult people more than older ones.

Hypothesis 4 When consumers choose a snack, the overall product perception (quality, flavor, and healthy perception) influences young-adult people more than Adult ones.

Young people at certain stages of their lives develop their preferences through experimentation. In this cycle of their lives, they likely find new options in terms of drinks, creating memories that are ultimately associated with their behaviors (Brownbill et al. 2020). These memories can strongly influence your future options. Meanwhile, Adults may have a greater established preference, making memory a lesser way of influencing decision-making processes (Falbe et al. 2021). Regarding marketing and promotional strategies, the beverage industry normally focuses on the young-adult population (Rojas-Rivas et al. 2020). In this way, these types of strategies create emotional connections and associations to your products. The young-adult population is more likely to be receptive and, therefore, to be predisposed to being able to give them satisfactory experiences in consumption. On the other hand, for scholars like Duong et al. (2021), young people tend to have a greater inclination for new products with unique and stimulating flavors. For their part, Adult populations will be inclined toward flavors that are more familiar to them, allowing them to reduce the impact of memory in product selection (McNaughton et al. 2020).

Regarding the consumption of snacks, young consumers tend to make longings with their childhood memories (Duarte et al. 2013). These memories may influence snack options since they recreate early experiences. For their part, Adult consumers may have a more significant number of experiences less related to their childhood (De Vlieger et al. 2017). These relationships can only be generated through a social and cultural context in which young and Adult consumers enjoy social suits. Memories play an important role in data that brings back memories of moments lived that can carry the possibility of living them again (Khvostenko et al. 2023; Stern 1962). Finally, through their advertising efforts, companies will seek to target market segments in which the target population has the characteristics of incorporating nostalgia rescued by branding and packaging (Khvostenko et al. 2023).

According to scholars such as Guitart et al. (2019), studies with eye-tracking have identified that the development of certain activities can affect memory, especially



when advertising different product characteristics. On the other hand, when there are conditions in which people are less exposed to the advertising given to products, whether beverages or snacks, the level of memory will be lower and, therefore, will influence, to a lesser extent, behavior related to consumption. Regarding age differences, it has been found that young people exhibit impulsive behavior. Therefore, they are less prone to maintaining information permanently. On the contrary, adult people are characterized by being more selective in the information they receive, rejecting what is relevant to them (Beuckels et al. 2021). Considering the previous postulates, the following hypothesis is proposed:

Hypothesis 5 When consumers choose a beverage, memory influences young-adult consumer segments more than Adult ones.

Hypothesis 6 When consumers choose a snack, memory influences young-adult consumer segments more than adults.

Methodology

Research design

The recruitment process was carried out systematically to ensure a diverse and representative sample of 90 adults between 18 and 65 for our study. The sample size of 90 adults was selected based on considerations of statistical power and feasibility in experimental design (D'Ambrogio et al. 2022), allowing for a manageable recruitment and data collection process within the constraints of the study's timeframe. The sample size is according to previous studies that use eye-tracking (Djamasbi et al. 2010; Sharif and Maletic 2010; Davenport 2007). The criteria used to demarcate between "young-adult" and "Adult" participants were a conventional age threshold; for the first case, it is understood as participants up to 45 years of age (Varona et al. 2004) and adults include people between 46 and 65 years.

Participants were recruited from the Pontificia Universidad Javeriana Cali, where the experiment took place. The study was conducted over two weeks, encompassing the academic period in January. This timeframe was selected in the regular academic calendar of the educational setting. Informed consent was obtained from all participants before they were included in the study.

To ensure a comprehensive representation of demographics, our sample selection process was guided by population distribution data provided by the Colombian National Administrative Department of Statistics (Dane). These data indicated a population distribution of 60% women and 40% men. Additionally, the socioeconomic distribution across economic levels was reported as follows: 40% falling within levels 1, 2, and 3, and 10% within levels 4, 5, and 6. Specifically, individuals aged 18 to 45 were categorized as "young adults," while those aged 51 to 65 were classified as "Adults." This division was informed by established age categories commonly used in consumer behavior studies (Baack et al. 2021). In each experiment, we ensured that the distribution of "young adult " (aged 18–45) and "Adult" (aged 45–65) reflected the proportions observed in Colombia's population demographics as provided by Dane (45% young-adult and 55% adult). Therefore, in the experiment, 41 were young adults and 49 adults. Education level distribution was considered as well. Specifically, 25% of the sample was represented by individuals with undergraduate education, 10% with postgraduate education, and 65% with education levels lower than postgraduate.

Experimental setup

Upon agreeing to participate, each participant entered the data collection phase. A distinctive feature of our approach was providing participants with a $5 credit to be redeemed for purchasing a snack and a beverage from the vending machine. This incentive was designed to enhance engagement and simulate a real purchasing scenario, promoting naturalistic behavior during the experiment.

Apparatus

We utilized state-of-the-art eye-tracking glasses to capture participants' visual attention and gaze behavior. These glasses featured cutting-edge technology, including Normalized 2D gaze locations and high-speed cameras operating at 200 Hz. Furthermore, the glasses were equipped with a Detachable Scene Camera that provided a $70° \times 70°$ field of view at 30 Hz @ 1088×1080px resolution. This comprehensive coverage enabled us to precisely track participants' eye movements while interacting with the vending machine.

The glasses' Automated AOI (Area of Interest) generation feature allowed us to track specific areas within the vending machine display (Fig. 1). Metrics such as Time to First Fixation, Time Spent, Ratio, Revisits, Fixation Count, and Mouse Clicks were used to analyze participants' engagement with various regions. These metrics were crucial for understanding how individuals interacted with the vending machine's offerings.

Vending machine

The Snack & Drink Vending Machine (SDVM) served as the focal point of our study due to its relevance to obesity-related concerns. Recognizing the significance of categorization in studying purchasing behavior, we meticulously organized



Fig. 1 Eye-tracking glasses

the nutritional information of 152 products available within the SDVM. Drawing inspiration from the "Vending" instrument, we tailored the local dietary needs and preferences classification criteria.

Classification of products was based on ten nutritional criteria, encompassing elements such as calories, saturated fat, trans fat, sugar, sodium, fiber, calcium, iron, vitamin C, and vitamin A. This comprehensive approach allowed us to evaluate the healthiness of products beyond simplistic criteria, considering multiple facets of their nutritional profile.

The classification was based on the nutritional density proposed by the "Vending" instrument, adjusted to the local environment by interest nutrients, and based on the original instrument's evaluative points. The analysis considered the size of the sales presentation and its relationship with ten nutritional criteria: calories, saturated fat, trans fat, sugar, sodium, fiber, calcium, iron, vitamin C, and vitamin A (Horacek et al. 2019; Matthews 2014).

To quantify the healthiness of foods, we calculated a cumulative score based on the nutritional criteria for each product. The cutoff points for each nutritional criterion were established (See Table 1), serving as thresholds for point allocation during the classification process. This approach facilitated a nuanced assessment of products, enabling us to distinguish between categories of healthiness.

Specifically, products achieving a cumulative score of ≥ 5 were classified as healthy based on their nutritional density. Conversely, products within the score range of 3 to 4 were categorized as neither particularly healthy nor unhealthy, representing an intermediate classification. Products garnering a cumulative score ≤ 2 were unequivocally deemed unhealthy due to their nutritional profile. These thresholds were instrumental in delineating clear boundaries between healthiness categories.

For a visual representation of the classification criteria and thresholds, refer to the provided Fig. 2, which visually communicates the process and outcomes of our classification system.

Horacek et al. (2019)

Table 1 The "Vending" instrument's sales evaluation criteria are based on nutrient density

Nutrient	Healthy criteria
Food (Range 0 to 10)	
Calories	≤ 200 cal per package
Saturated Fat	$\leq 10\%$ off recommended daily rates per package
Fat trans	0% per package
Sugar	$\leq 12{,}5$ g per package
Sodium	$\leq 10\%$ of recommended daily values per package
Fiber	$\geq 10\%$ of recommended daily values per package
Calcium	$\geq 10\%$ of recommended daily values per package
Iron	$\geq 10\%$ of recommended daily values per package
Vitamin A	$\geq 10\%$ of recommended daily values per package
Vitamin C	$\geq 10\%$ of recommended daily values per package
Beverages (Range 0 to 2)	
0	Beverages for athletes/water/vitamin water (> 50 cal per 8 oz) - Beverages with sugar/energy drinks/coffee drinks/lemonade/ice cream/all other beverages (> 10 cal per 8 oz)
1	There is no 100% fruit or vegetable juice Milk/flavored milk/lactose-free milk alternatives (> 150 cal per 8 oz) Beverages with sugar/energy drinks/coffee drinks/lemonade/ice cream/all other beverages (10 cal per 8 oz of liquid)
2	Aromatized water 100% fruit or vegetable juice Milk/flavored milk/lactose-free milk alternatives (150 cal per 8 oz)



Fig. 2 Vending Machine with products. *Note* The pictures were taken during the experiment

Experimental design

Our experimental design encompassed participants across different age groups, accommodating both young adults and Adult individuals. The participants were tasked with selecting snacks and beverages in tandem, mimicking real-world decision-making scenarios. The assessment of their choices revolved around cognitive processes involving perception and memory. Participants' evaluation criteria included flavor, quality, perceived healthiness, and brand reputation. These cognitive aspects were expected to influence their purchase decisions.

Eye movement data analysis

The eye movement data collected through the eye-tracking glasses underwent a meticulous analysis. Fixations, characterized by prolonged visual fixations on specific areas of interest, were detected and categorized. To ensure accuracy, fixations lasting less than 70 ms were excluded, as these were considered typical ocular movements rather than indicative of genuine interest. We identified four critical areas of interest within the vending machine's display: brand, nutritional labels, screen center, and other sections. Each fixation was categorized based on which AOI it fell within. This categorization allowed us to comprehend participants' engagement patterns and determine the sections that held their attention during the purchasing process. To mitigate potential errors caused by limitations in the eye-tracking technology, we incorporated a measurement buffer of 3 mm to the size of each product. This buffer was designed to account for variations in fixation precision and to prevent misinterpretation of fixations as participants shifted their gaze between adjacent points.

The sequence of fixations and saccades was analyzed to decipher the participants' visual behavior. This analysis provided insights into how participants navigated through the vending machine's offerings. By scrutinizing the sequence and duration of fixations, we aimed to uncover any discernible patterns or trends that could shed light on the decision-making process.

Pilot process

In the pilot phase of the experiment, participants were positioned approximately 55 cm away from the vending machine. This positioning enabled us to capture their eye movements and visual behavior precisely. The average duration of the entire purchase process, encompassing selecting a snack and a beverage, was around 70 s. This timing encompassed participants' engagement with the vending machine, their decision-making process, and the final selection of items.

Each participant was directed to complete a comprehensive questionnaire after the purchase process. This questionnaire, adapted from Kirchoff et al. (2021), encompassed a range of topics. Participants were prompted to provide sociodemographic information, including age, gender, and educational background. Moreover, the frequency of using vending machines and related cognitive processes—such as perception and memory—were probed. The questionnaire also explored factors influencing purchase decisions, including pricing considerations, brand recognition, flavor preferences, and hunger levels during decision-making.

Each participant was directed to complete a comprehensive questionnaire after the purchase process. This questionnaire, adapted from Kirchoff et al. (2021), encompassed a range of topics. Participants were prompted to provide sociodemographic information, including age, gender, and educational background. Moreover, the frequency of using vending machines and related cognitive processes—such as perception and memory—were probed. The questionnaire also explored factors influencing purchase decisions, including pricing considerations, brand recognition, flavor preferences, and hunger levels during decision-making.

In the first experiment, products from all categories—healthy and somewhat healthy—are included in the Vending machine to see which are the most popular. This experiment includes the same number of products for each category in snacks and beverages.

Results

Experiment 1

Number of fixations

In our investigation of labeling-related factors and perceptions, the analysis of fixations provided valuable insights into visual engagement. For both product types (snacks and beverages) and categories (healthy and somewhat healthy), participants exhibited similar thresholds for labeling-related factors, reflecting consistent visual attention.

Brand focus and decision time

Noteworthy distinctions emerged in brand focus and decision-making time across product categories. Participants dedicated more time to brand-related questions in the beverage category than snacks, indicating brand recognition's importance in beverage choices. This effect was further pronounced among young-adult participants.

On the other hand, snacks garnered more fixations than beverages. The additional analysis time allocated to snacks, evident in young-adult ($M = 4.91$) and Adult consumers ($M = 4.97$), they were suggested that consumers exhibited a deeper scrutiny of snack offerings.

Perceptions and pupil size

Employing pupil size as an objective measure of perception yielded interesting findings. The analysis revealed a more significant role of pupil size in influencing beverage choices for elderly individuals ($M = 5.91$) compared to young-adult participants ($M = 5.11$). This result refuted Hypothesis 1, which posited a stronger impact of perception on young-adult people's beverage selections ($F(1, 90) = 11.99$, $p < 0.001$).

However, regarding snacks, no statistically significant differences in perceptions were observed between young and Adult participants ($M = 3.16$ versus 3.56). Hypothesis 2, suggesting a stronger influence of perception on young-adult individuals' snack choices, was rejected ($F(1, 90) = 7.68$, $p > 0.1$) (See Graph 1).

Overall product perceptions

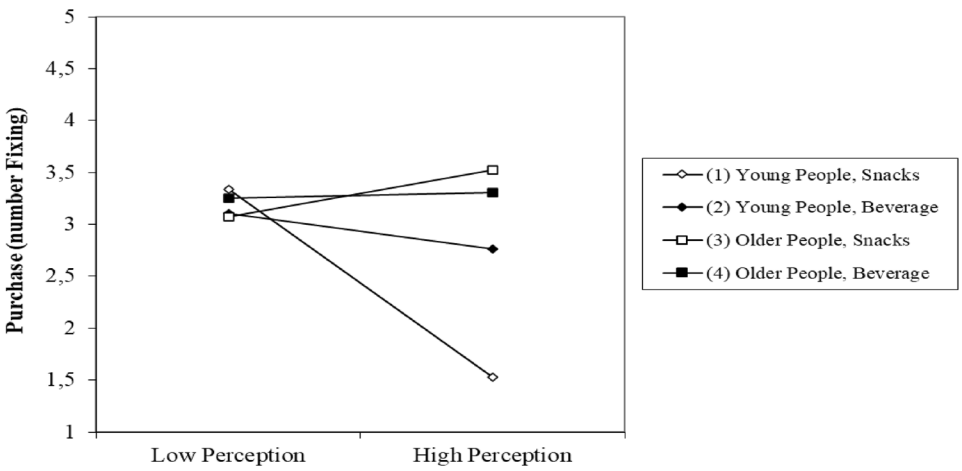
The integration of taste, quality, and perceived healthiness into a single factor allowed the assessment of overall product perceptions (KMO: 0.91: Cronbach's Alpha: 0.88). Interestingly, Adult consumers attributed higher value to the overall perception of beverages ($M = 5.33$) compared to young-adult participants ($M = 4.76$); $F(1, 90) = 13.60$, $p < 0.001$). In contrast, young-adult consumers exhibited a stronger focus on the overall perception of snacks ($M = 5.41$), surpassing the perceptions of their Adult counterparts ($M = 5.30$); $F(1, 90) = 12.87$, $p < 0.001$)). As a result, Hypothesis 3 is rejected, which states that when consumers choose a beverage, its overall perception (quality, flavor, and health perception) impacts young-adult customer groups more than Adult ones.

This contrast in preferences supported the confirmation of Hypothesis 4, suggesting that young-adult individuals' product choices are more influenced by overall product perception in the context of snacks (See Graph 2).

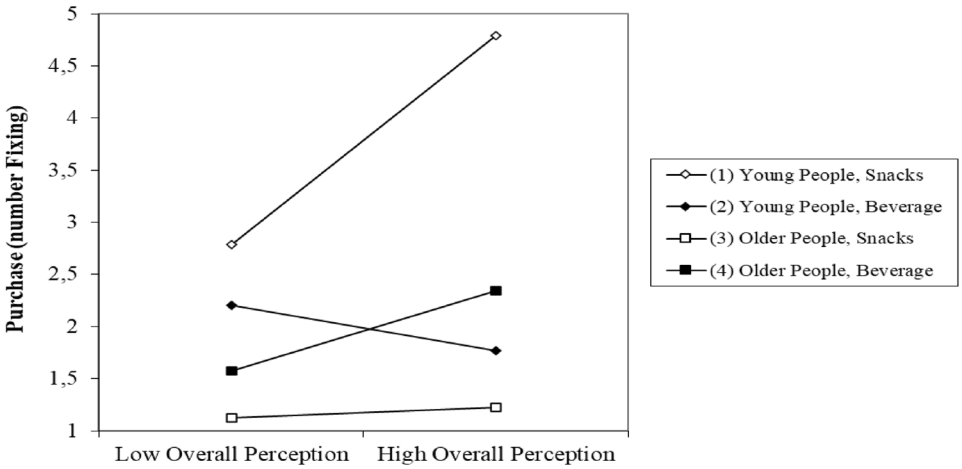
Memory and brand influence

Memory's influence on purchasing decisions was evaluated through answers provided in a questionnaire related to brand memory. Particularly for young individuals, memory emerged as a crucial factor when choosing beverages, with a mean score of 5.12 compared to 4.03 for Adult participants

Graph 1 Perception



Graph 2 .



(F(1, 90) = 12.65, $p < 0.001$). Interestingly, this significance was not mirrored in snack choices, indicating that memory was less relevant to Adult individuals but more so for the young-adult cohort (See Graph 3).

Consequently, Hypothesis 5 was affirmed, indicating that memory impacts young people more than Adult ones when choosing beverages. Additionally, Hypothesis 6 was confirmed, demonstrating that memory influences young people more than Adult ones in the context of snack choices.

Experiment 2

Several fixations and decision-making

Transitioning to healthy products in Experiment 2, the examination of fixations unveiled intriguing decision-making patterns. Healthy snacks garnered more fixations than healthy beverages, with both young ($M = 4.91$) and Adult consumers ($M = 4.97$) exhibiting this behavior. The inclination toward detailed analysis and time investment was consistent across age groups (F(1, 90) = 12.15, $p < 0.001$)).

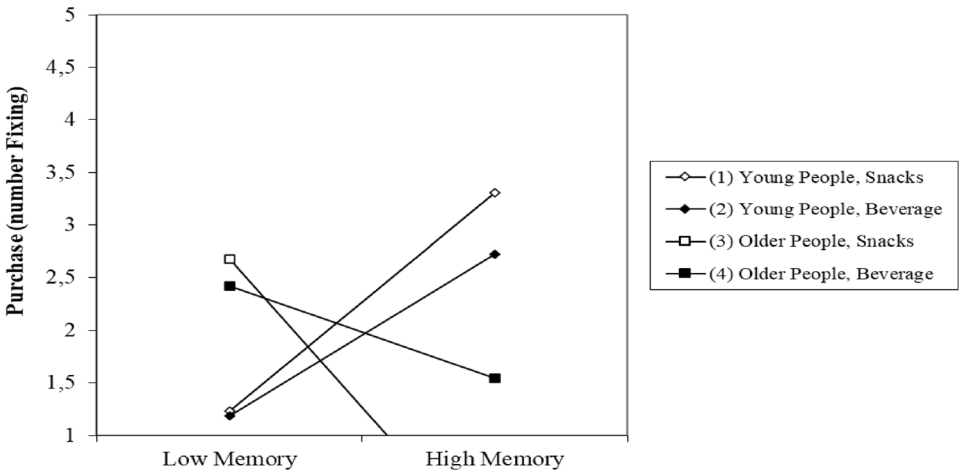
This phenomenon suggested that healthy snack choices demanded a more meticulous evaluation, reflecting consumers' importance on their nutritional value and other attributes.

Perceptions and overall product perceptions

In healthy product perceptions, interesting disparities emerged between young and Adult consumers. Contrary to Hypothesis 1, healthy beverages generated more positive perceptions among Adult individuals ($M = 5.22$) compared to their young-adult counterparts ($M = 4.34$); F(1, 90) = 12.11, $p < 0.001$)). This result indicates that Adult consumers attributed higher value to the inherent health benefits of beverages, leading to more favorable perceptions.

However, Hypothesis 2 was affirmed, indicating a more excellent positive perception of healthy snacks among young consumers ($M = 5.80$) compared to Adult participants ($M = 5.02$). This positive perception in the young cohort could be attributed to their inclination toward healthier snack

Graph 3 .



options, possibly due to health-conscious trends among this age group.

Overall product perceptions and memory impact

Given the focus on healthy products, the interplay between overall product perceptions and memory held valuable insights. Young consumers continued to place a higher emphasis on the overall perception of products ($M = 5.33$) compared to Adult participants ($M = 4.76$) when selecting beverages ($F(1, 90) = 13.60$, $p < 0.001$)). The importance of the product's overall impression highlighted young consumers' proactive approach to choosing healthful options.

Interestingly, this relevance of overall product perception extended to healthy snacks, confirming Hypothesis 4 once again. The data indicated that young consumers ($M = 5.33$) perceived overall product qualities with greater significance compared to their Adult counterparts ($M = 4.76$), $F(1, 90) = 12.1$, $p < 0.001$)).

Memory and brand influence

The role of memory remained significant in young individuals' choices of healthy beverages ($M = 5.12$) and snacks ($M = 5.12$), where memory played a crucial role in influencing their preferences. This memory-driven influence lent support to both Hypotheses 5 and 6, reinforcing the impact of memory on young-adult participants' decisions.

Experiment 3

Several fixations and decision patterns

Experiment 3, featuring somewhat healthy products, provided insights into consumer behavior across age groups. Interestingly, participants tended to make quicker decisions for beverages and snacks, indicating a more concise decision-making process. Young-adult consumers, in particular, were observed to make snap decisions, whereas Adult participants displayed a penchant for careful analysis.

This behavior might be attributed to the consumer's perception of somewhat healthy products falling between distinct categories, prompting quicker evaluations to strike a balance between health and indulgence.

Perceptions and total product impressions

Perceptions of somewhat healthy products revealed notable age-related trends. Young consumers displayed more positive perceptions of somewhat healthy beverages ($M = 5.11$) than Adult individuals ($M = 4.45$), supporting Hypothesis 1. The positive perception of somewhat healthy beverages among young consumers might stem from their inclination to prioritize a balance between health benefits and palatability.

This pattern extended to somewhat healthy snacks, corroborating Hypothesis 2. Young-adult individuals ($M = 5.80$) viewed somewhat healthy snacks more favorably than their Adult counterparts ($M = 5.02$). This result underscores the influence of the perception of "somewhat healthy" in shaping the preferences of young-adult consumers.

Overall product perceptions and memory impact

The interplay of overall product perceptions and memory came to the forefront in Experiment 3. Both young and Adult consumers placed greater emphasis on overall product perception in the context of somewhat healthy products, thereby confirming Hypotheses 3 and 4. This emphasis suggests that consumers consider a product's holistic appeal when navigating the complexities of somewhat healthy options.

Memory's influence on purchasing decisions continued to manifest in Experiment 3. The data revealed that memory significantly impacted young participants' choices of both somewhat healthy beverages ($M = 6.19$) and snacks ($M = 6.06$), reinforcing Hypotheses 5 and 6. This result underscores the enduring role of memory in consumer behavior, even in scenarios involving products with nuanced health attributes.

Comprehensive consumer decision-making

The findings from Experiment 3 underscore the multifaceted nature of consumer decision-making when presented with somewhat healthy options. Participants of all ages demonstrated a dynamic interplay between perceptions, memory, and overall product impressions, indicating that a delicate balance of factors influences consumer choices within this category.

Table 2 Study hypothesis

Hypothesis	Experiment 1	Experiment 2	Experiment 3
H1	Reject	Accept	Accept
H2	Reject	Accept	Accept
H3	Reject	Accept	Accept
H4	Accept	Accept	Accept
H5	Accept	Accept	Accept
H6	Accept	Accept	Accept

The following Table 2 shows the accepted and rejected hypotheses in the 3 experiments.

Conclusions

This study investigated how individuals buy snacks and beverages from Vending machines in educational environments. We explored the aspects impacting customer decision-making through three studies, including the number of fixations, perceptions, overall product perceptions, and memory. The Experiments showed that participants exhibited a higher number of fixations and engaged in a more analytical decision-making process when considering healthier snack options compared to less healthy options. This situation suggests that consumers consider health-related factors more carefully when choosing healthier snacks.

One key finding highlighted in the study was the distinct behavior exhibited by consumers when choosing between healthier and less healthy options. Consumers demonstrated a higher level of visual engagement and engaged in a more analytical decision-making process when considering healthier snack alternatives. This suggests that health-related factors played a more significant role in their decision-making, underlining the importance of promoting healthier choices in vending machines.

Moreover, the study provided valuable insights into the role of brand recognition and brand focus in consumer choices. It revealed that participants allocated more decision-making time to brand-related questions in the beverage category compared to snacks, particularly among young adults. This underscores the significance of brand recognition in beverage choices, especially among younger consumers.

The study also examined the influence of perception on product choices, differentiating between beverages and snacks. Notably, it found that while perceptions significantly impacted beverage choices for elderly individuals, no statistically significant differences in perceptions were observed between young and adult participants for snacks. These findings challenge previous hypotheses and contribute to a nuanced understanding of perception's role in consumer decisions.

Regarding overall product perceptions, the study identified variations between age groups. Adult consumers attributed higher value to the overall perception of beverages, whereas young-adult participants exhibited a stronger focus on the overall perception of snacks. This contrast in preferences highlights the importance of tailoring marketing and nutritional profiles to align with consumer age groups and preferences.

Memory's role in influencing purchasing decisions was a significant aspect of the study. It was observed that memory played a crucial role in beverage choices, particularly for young individuals. This emphasizes the impact of memory in shaping preferences, particularly in the context of beverages.

The study also conducted experiments focusing on healthy and somewhat healthy products, revealing distinct decision-making patterns. Notably, participants exhibited quicker decision-making for somewhat healthy options, reflecting the challenge of balancing health and indulgence in consumer choices.

Therefore, the study provided a detailed and comprehensive analysis of consumer behavior in vending machine purchases. It offered valuable insights into the factors influencing decision-making, including fixations, perceptions, overall product perceptions, and memory. These findings have practical implications for promoting healthier choices in educational settings and offer guidance for marketers, policymakers, and food service providers looking to tailor their offerings to diverse consumer preferences and age groups. The reviewer recognized the significant improvements made in emphasizing the study's findings and contributions.

Theoretical Implications

This study draws on existing research, such as Qian et al. (2023) and Otterbring et al. (2018), to emphasize the influence of symbol shapes in product images on consumer habits, particularly in male consumption patterns. It highlights that product attributes, including symbolism, can have varying impacts on consumer behavior across different demographic segments, with particular emphasis on age-related differences.

The study posits hypotheses that link perception, overall product perception (quality, flavor, and healthy perception), and memory to consumer choices, recognizing the differing levels of influence on young-adult and older consumer segments. These hypotheses underscore the importance of considering cognitive processes and age variations in understanding consumer behavior in the context of beverage and snack choices from vending machines. Moreover, the study aligns with existing literature on how product design, advertising, and packaging can shape consumer preferences and memories, highlighting their potential to influence future product selections. It suggests that memory and emotional connections play a pivotal role in guiding consumer choices, particularly among young-adult populations.

Theoretical implications are centered on the interplay of cognitive processes, age-related preferences, and the role of product attributes and branding in shaping consumer behavior. These implications contribute to a deeper understanding of consumer choices in the context of beverages and snacks

and underscore the need for tailored marketing strategies that account for these factors.

Practical implications

The findings from studies such as Qian et al. (2023), Otterbring et al. (2018), Diouf et al. (2023), Lo et al. (2017), and McNeill et al. (2017) provide practical implications for businesses in the marketing analytics field. These implications include tailoring marketing materials to leverage symbol shapes that resonate with specific consumer demographics, developing segmented marketing strategies based on symbols, choosing advertising approaches that align with target demographics' preferences and persuasion levels, utilizing packaging and design to effectively communicate product attributes, incorporating eye-tracking technology in consumer research to optimize product displays and materials, crafting memory-based marketing campaigns that trigger positive associations, particularly among young adults, and recognizing the influence of color on perceptions to shape consumer expectations. Additionally, targeting young-adult consumers with emotional connections and unique flavors can enhance marketing effectiveness, while data-driven advertising can tailor campaigns to individual preferences and behaviors, ultimately improving engagement and conversion rates.

Limitations and future research

Cognizant of the delineated scope and parameters, we remain attuned to the boundaries that have circumscribed our investigations. While our insights are instructive, their applicability may be circumscribed by the specific educational setting under examination. Our partial engagement with factors such as fixations, perceptions, and memory mandates a recognition of the broader pantheon of influences, including price dynamics and packaging aesthetics. Additionally, categorizing products into health-related strata bespeaks an inherent subjectivity, underscoring the exigency for calibrated categorization frameworks.

The vistas of future inquiry beckon with tantalizing prospects. Venturing beyond the precincts of educational enclaves to encompass a broader spectrum of consumer habitats would engender greater external validity to our findings. An encompassing comprehension of consumer comportment necessitates the inclusion of an expanded constellation of variables, encompassing facets like the influence of price perceptions and packaging aesthetics. A concerted endeavor to establish empirically grounded, standardized product categorization criteria would bestow enhanced precision upon our interpretative framework.

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Declarations

Competing interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

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