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Effect of Recipient's Tactile Properties and Expectations on Beer Perception

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Abstract: Our perception of food is influenced by various factors, including its sensory properties, the environment in which it is consumed, and the tools we use to consume it (cutlery, glasses, etc.). The purpose of this study was to examine how the texture of the glass used to drink beer affects the perception and emotions generated by the experience. Two tasting sessions were conducted, where participants were served two types of beer (alcoholic and non-alcoholic) in four glasses with different textures. The participants rated liking, the perceived differences in several sensory attributes using a Just-About-Right scale, and the emotions elicited by the drinking experience using a Check-All-That-Apply question. The results indicated that the texture of the container did not affect the participants' perception of the alcoholic beer. However, for the non-alcoholic beer, participants liked the sample served in the glass with a plain surface over the ceramic glass. Participants' awareness of drinking a non-alcoholic beer did not affect any of the studied attributes. The results of this study suggested that different textured glasses could be used to differentiate brands, restaurants, etc., from competitors and create a unique identity without significantly affecting the perception of beer properties.

Keywords: texture; haptic sensation; flavor; ceramic; expectations

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1. Introduction

Beer is one of the most popular alcoholic beverages throughout the world, and its consumption is rapidly growing. The global beer market is set to grow from USD 768 billion in 2021 to over USD 989 billion in 2028 at a CAGR of 3.68% [1]. Specifically, in Europe, the beer industry is expected to grow at an annual rate of 6.20% and generate a revenue of USD 155.90 billion in 2023 [1,2]. Considering these expected growth patterns, it becomes indispensable to understand the factors that may affect the taste, flavor, and overall perception of beer to offer the best quality product and give a better beer-drinking experience to current and future consumers.

The physicochemical composition of the beer greatly influences its perception; not only the compounds generated during the brewing process, but the origin and characteristics of its raw materials have been proven to affect its flavor quality [3]. The interaction between different compounds, such as CO_2 and ethanol, has been reported to be responsible for creating a complex experience when drinking beer [4]. Besides its chemical composition, the other physicochemical properties of beer have an important effect on beer perception. The appearance of the beer, including color [5] and foam [6,7], can affect its perceived taste and quality [8], as well as the expectations related to taste and price [9]. For example, Donadini et al. [6] showed that foam and lacing patterns generated expectations regarding some beer attributes such as sweetness, bitterness, fruitiness, perceived level of alcohol, effervescence, and the thirst-quenching character of the samples tested by Italian consumers. Carvalho et al. [9] reported different expectations from consumers when a beer sample with

a specific flavor profile was served with two different colors; the sample with the darker color was expected to be more expensive than the pale one. Therefore, several studies have considered the intrinsic factors (product properties such as color, volatile composition, etc.) that are directly related to beer perception, but just a few studies have related the extrinsic factors (e.g., label, price, etc.) of beverages with the consumer's perception of its aroma, taste, and/or hedonic responses [10–12]. Some of these studies have shown that the information that consumers have about the product can influence consumers' response; for example, a "non-alcoholic beer" label was reported to affect the emotional response of consumers when drinking beer in a bar setting [10]. Finally, the different characteristics of a real context environment (e.g., a bar or a restaurant), such as the auditory pitch, can also affect the perception of the product and even beer choice [13,14].

One of the potential explanations for some of the aforementioned interactions between explicit stimuli and beer perception are crossmodal correspondences. Crossmodal or multimodal correspondences are the associations that people make from different sensory modalities onto each other [15]. For example, a significant visual–gustatory correspondence has been identified when drinking beer, with sweetness being associated with voluminousness and roundness, and bitterness being associated with thinness and angular shapes [16]. Considering these crossmodal relationships, it could be hypothesized that the exposure to specific tactile stimuli could elicit a modification in the perception of some of the flavor attributes of the beer (e.g., alcoholic sensation, sweetness, bitterness, etc.), which could ultimately affect the experience of consuming or choosing a specific product.

Over the years, beer has been drunk in different types of recipients made of different materials such as ceramic, sterling silver tankards, glass, bottles, and cans [17], although the most common material for drinking beer is glass. However, the container (extrinsic criterion) may affect the beer flavor (intrinsic property), making the product more liked if the consumer is pleased with the drinking recipient because it is congruent with his/her expectations [18]. The shape of the packaging has been reported to be a significant key parameter due to the tactile sensation given to the consumer when holding it; in general, the different attributes of packaging can impact the consumer's perception of the flavor of the contents [19]. Barnett et al. [20] showed that consumers who evaluated beer served from a bottle rated it as tasting better than those who tasted it served from a can, although the beer was the same and the samples were similarly rated when tasted in blinded conditions. One of the potential explanations that these researchers offered to justify their results was linked to the differences in weight between the containers. The visual detail of the container may also confer a genuine significance in the attraction of the product [21,22], or elicit specific expectations [23], and therefore it could have an impact on the taste of the beer. For example, Mirabito et al. [12] showed that the shape of the container in which beer was served changed its perceived taste, and rounded glasses elicited a higher fruitiness and overall flavor intensity in the samples. Therefore, some of the visual aspects and tactile stimuli of the beer container have already been investigated (e.g., shape), but scarce is the research on other haptic stimuli associated with the drinking experience (e.g., the texture of the container). Modifying the tactile sensation through changes in the textures of the surface of a glass or bottle used to drink beer could trigger different perceptions of the beverage.

The aim of this study was to investigate the influence of the texture of the container surface on the sensory perception of a non-alcoholic and an alcoholic beer. The experimental design included a ceramic glass, a representative of an ancient method of drinking beer that could bring different tactile sensations. Also, because the information that consumers receive on the samples could also influence samples' acceptance and perception, a secondary objective of the study was to determine if having data about one product to be tested (the non-alcoholic beer) would influence its perception. A non-alcoholic product was chosen because interest in non-alcoholic beers is growing, and having information on how to provide consumers with a quality drinking experience could help brewers meet the challenge of bringing new low-alcohol products to the market [24].

2. Materials and Methods

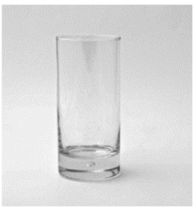
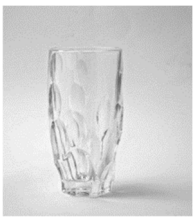
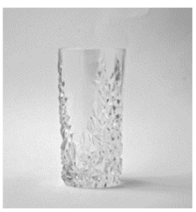
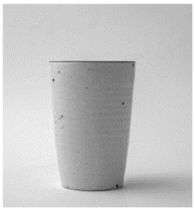
2.1. Participants

The protocol for the consumer study was approved by the Basque Culinary Center scientific committee, which stated a waiver of consent (BCC22/1703-2). All articles from the Declaration of Helsinki and the 2016/679 EU Regulation on the protection of natural persons regarding the processing of personal data were met. A total of 120 healthy adult participants, in a ratio of 3:2 (female to male), who were willing to consume alcoholic beverages, were recruited from the Basque Culinary Center (BCC) consumer database to participate in the two sessions of the study. The tastings were held at BCC's sensory lab facilities with controlled temperature and relative humidity, 21 ± 2 °C; 55 ± 5% RH; the illumination was a combination of natural and non-natural light (fluorescent).

2.2. Stimulus and Sample Selection

The study used four different containers with distinct textures, named Plain, Bubbly, Prickly, and Ceramic, to evaluate their impact on the sensory properties of two beer samples. An image and a brief description of each glass are shown in Table 1. Three of the containers were made of glass while the fourth was a ceramic vessel. The containers had a similar shape, volume, and weight to ensure that the volatile compounds released by the beer would not vary significantly, and that the main difference between the experiences would be the tactile sensation provided by the container. All the recipients were purchased from a local supplier (Industrial San Miguel, Spain).

Table 1. Description of the recipients used in this study.

Name	Material	Description	Shape
Plain	Glass	A highball glass with a plain texture.	
Bubbly	Glass	A highball glass with "bubbles" in the surface.	
Prickly	Glass	A highball glass with irregular shapes in the surface, creating a rough/sharp texture.	
Ceramic	Ceramic	A highball opaque glass with a slightly rough texture.	

Two lager beers with similar appearance were selected for the present study: Manila (Mahou-San Miguel, Spain; 5.8% ABV) (sample "A") and Amstel Oro Tostada (Heineken España, S.A., 0.0% ABV) (sample "NA"). The samples are described using different sensory descriptors in the corresponding brewer's webpage: Sample A "*with amber color, bright appearance, and creamy and consistent foam. Intense hop character with a wide variety of notes, among which herbal, floral, and resin aromas stand out, with hints of tropical fruit. In the background there are flavors of caramel and toasted malts. When swallowing, the hoppy notes are enhanced, and certain notes of alcoholic fragrance appear*". And sample NA "*characterized by its intense aroma related to malting, which also brings a golden copper color to the beer. Made using four kinds of toasted malts which brings notes of chocolate mocha or coffee in the first sip*". The samples were refrigerated at 4–6 °C before the tasting sessions. During these sessions, samples (50 mL) were served to the 4 different recipients, coded with 3-digit random numbers, and randomly served to participants. Participants were informed that they would be drinking 4 different beer samples; therefore, participants were not aware that only one kind of beer was served. Five minutes of resting was allowed between samples and water was served for palate cleansing.

2.3. Experimental Design and Questionnaire

A total of 120 responses were collected on the non-alcoholic (NA) beer perception served in the 4 different glasses. To test whether having information about the type of beer they were drinking had any impact on the response, 60 consumers received no information on the kind of beer they were drinking (NI condition), while the other 60 consumers were aware that they were drinking non-alcoholic beers (I condition). Additionally, consumers who tasted the non-alcoholic beer under blinded conditions (NI) repeated the experiment with the alcoholic (A) beer samples.

The questionnaire used to collect responses consisted of different types of questions to assess the participant's perception of the beer related to different glassware types. These included: (a) the 9-point hedonic scale (1 = extremely dislike; 5 = neither like, nor dislike; 9 = extremely like) to assess liking; (b) some Just-About-Right (JAR) questions to identify variations in the perception of different beer attributes (1 = extremely low intensity, 5 = Just-About-Right, 9 = extremely high intensity); and (c) a Check-All-That-Apply (CATA) question with the 11 emotions included in the lexicon developed by Mora et al. [25] for beer evaluation: ENTHUSIASM, DISAPPOINTMENT, NOSTALGIA, DISGUST, DISSATISFACTION, PLEASURE, VIGOUR, DESIRE, INDIFFERENCE, FUN, and MILDNESS.

The choice of sensory attributes to be assessed to test whether the tactile sensation of the glass would modify its perception (JAR questions) was based on responses gathered through an online questionnaire on general aspects and preferences of beer types among Spanish consumers (n = 108, results not shown). Respondents indicated that the most relevant attributes for selecting a beer were sweetness, bitterness, hop flavor, toasted flavor, malts flavor, and alcoholic sensation, and therefore these were the attributes included in the questionnaire. The results of the online questionnaire also showed that 79% of respondents would rather drink beer out of a glass than drink directly from the bottle or can, confirming the importance to the present study.

2.4. Data Analysis

Data were analyzed using a two-way ANOVA (analysis of variance) using "beer" (only data from the blind condition and including samples A and NA), "texture", and "information" (only data from the non-alcoholic beer and comparing I and NI responses) as independent variables; liking and the different attributes evaluated (JAR questions) were considered the dependent variables. CATA results were analyzed using a Chi-squared test and Cochran's Q test with paired comparisons based on the Sheskin critical difference method to identify significant differences between the emotions linked to each beer type or condition. A significance level of $p \leq 0.05$ was used for every test. Statistical analyses were performed using version XLSTAT 2022.1.06 (Addinsoft, New York, NY, USA).

3. Results

The results of the data analyses indicated that "beer" and "texture" had a significant effect on liking, while the interaction "texturexbeer" did not have a significant impact on liking or on the perception of the different beer attributes. The beer with alcohol (A) was more liked than the beer without alcohol (NA) (Table 2), with all its attributes (sweetness, bitterness, hop flavor, toasted flavor, malt flavor, and alcoholic sensation) being closer to the Just-About-Right score than the ones of the non-alcoholic beer.

Table 2. Results of the two-way ANOVA showing the effect of beer type.

Beer Type *	Liking	Sweetness	Bitterness	Hop Flavor	Toasted Flavor	Malt Flavor	Alcohol
A	6.36 a	4.48 a	5.33 a	5.07 a	4.59 a	4.80 a	4.88 a
NA	4.87 b	4.14 b	4.18 b	3.90 b	3.73 b	4.34 b	3.43 b
p-value	<0.001	0.029	<0.001	<0.001	<0.001	0.003	<0.001

* Legend: A = beer with alcohol; NA = non-alcoholic beer. Different letters within the column indicate different post hoc groupings by Tukey's HSD ($p < 0.05$).

The texture/material of the glasses did not affect the liking or perception of the sensory attributes of the alcoholic beer (A sample), with the sample being perceived in a similar way regardless of the type of glass in which it was drunk. On the contrary, the texture/material of the glasses significantly influenced the liking of the non-alcoholic beer sample (NA) (Table 3), with the sample that was drunk in the plain glass being more liked than the sample that was drunk in the ceramic glass. The perception of the sensory attributes assessed in the NA sample was similar in all the glasses used to drink the beer, with liking being the only parameter affected. Finally, informing consumers that the sample corresponded to non-alcoholic beer ("information" factor) did not influence liking or the perception of its attributes; both consumer groups I and NI provided similar ratings.

Table 3. Results of the two-way ANOVA showing the effect of glass texture on the attributes of non-alcoholic beer.

Texture	Liking	Sweetness	Bitterness	Hop Flavor	Toasted Flavor	Malt Flavor
Ceramic	4.64 b	4.05	4.45	4.13	3.94	4.38
Diamond	5.18 ab	4.51	4.29	3.97	3.66	4.44
Plain	5.38 a	4.13	4.29	3.78	3.77	4.08
Bubble	4.98 ab	4.16	4.25	4.01	3.73	4.33
p-value	0.036	0.213	0.851	0.433	0.656	0.431

Different letters within the column indicate different post hoc groupings by Tukey's HSD ($p < 0.05$).

Figure 1 shows the byplot of the emotional responses by beer type and glass. Cochran's Q test showed significant differences among samples in all the emotions during the blinded condition testing (alcoholic vs. non-alcoholic beer). These findings suggested that there was a strong association between the alcoholic beer (A), which was liked more than the non-alcoholic sample (NA), with positive emotions such as FUN, ENTHUSIASM, DESIRE, PLEASURE, NOSTALGIA, and VIGOUR. On the contrary, a correlation between non-alcoholic beer (NA) was observed with negative emotions such as DISGUST, INDIFFERENCE, DECEPTION, DISSATISFACTION, and MILDNESS.

Cochran's Q test showed significant differences among samples for the emotions DISGUST, VIGOUR, FUN, and MILDNESS during the testing conducted with non-alcoholic beer (Figure 2). The Chi-squared test showed significant differences between the informed vs. non-informed condition for PLEASURE, with the informed condition eliciting a higher pleasure than the non-informed one.

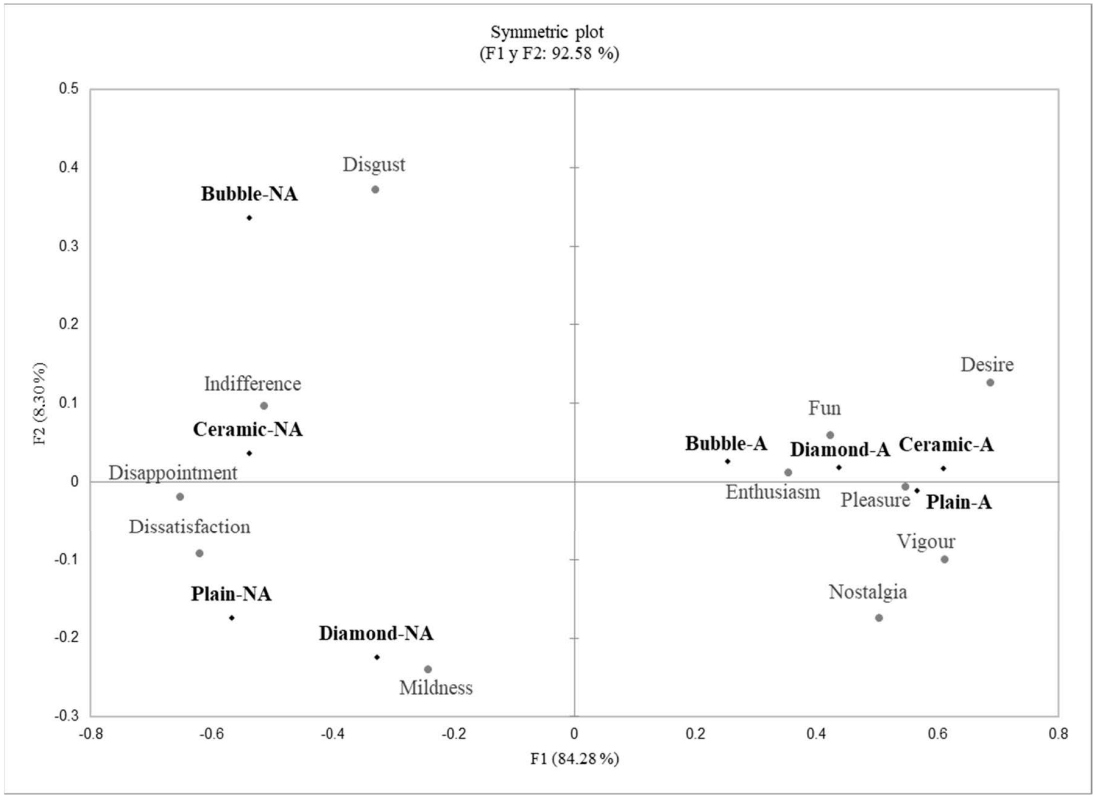


Figure 1. The symmetric plot of emotions with the beer type and the texture of the recipient (blinded condition). Legend: A = beer with alcohol; NA = beer without alcohol.

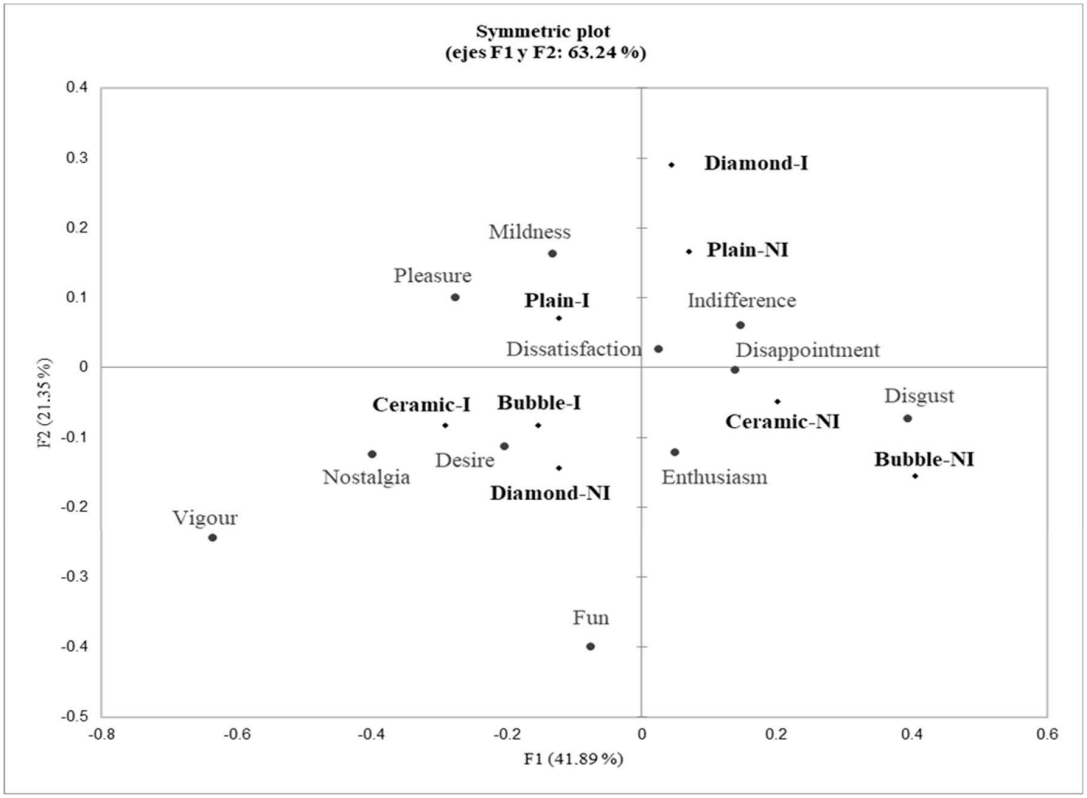


Figure 2. Symmetric plot of emotions with informed/not informed conditions results and the texture of the recipient. Legend: I = informed and NI = not informed condition.

4. Discussion

Results from different studies have described various crossmodal relationships of haptic sensations in beverage vessels with perceived alterations in the attributes of the product. For example, Lago et al. [11] reported that a modification in the texture of the holder of a cup changed the perception of the sweetness of iced tea samples. Sweet perception was not affected by the texture of the glass in the present study. It is possible that some crossmodal associations are product-specific, and therefore cannot be extrapolated and assumed in different product categories (e.g.,: iced tea and beer). Piqueras-Fiszman and Spence [26] showed that the texture of the container could influence consumers' ratings of some texture attributes in biscuits and yogurts, but texture was not assessed in the present study because the sample was a drink. However, alcoholic sensation, a mouthfeel present in beer, was assessed, and it was similarly perceived regardless of the glass. Attwood et al. [27] reported a slower consumption of a lager beer from a straight glass compared to a curved glass, showing a potential effect of glass shape on alcohol consumption. Van Rompay et al. [28] reported significant differences in the basic taste perception of ice creams when served in sharp or smooth surface cups. The results of the present research suggested that the chosen tactile sensations did not influence the perception of the main beer flavor attributes, nor the alcoholic sensation (JAR responses), although drinking rate was not studied in the present research and all glasses had a similar shape, as opposed to the study reported by Attwood et al. [27]. The non-alcoholic beer sample that was drunk in the ceramic vessel was less liked than the sample drunk in a smooth-surface glass, but none of its attributes seemed to be perceived in a different manner depending on the glass. Further studies should be conducted with other beer types (e.g., ale beers with higher fruity notes, IPA beers with higher hop flavor intensity, etc.) and a wider range of tactile sensations to verify if these results could be generalized, or whether some specific beer products/properties could be significantly affected by the haptic stimuli of the glass.

Krishna and Morrin [29] suggested that the effect of the haptic sensation on food perception could be different depending on the personal profile (high vs. low autotelic profiles, with high autotelics being those who have a clear preference for touch to enjoy sensory feedback [30]). No segmentation was conducted in the present research to classify consumers, a fact that could have influenced the results. Future research could consider this personal profile of consumers, as well as other kinds of consumer segments related to beer-drinking attitudes [31] to determine if some specific segments of consumers are more sensitive to modifications of the drinking experience. Moss et al. [32] reported that consumers interested in a healthy lifestyle, or those who want to decrease alcohol consumption, were more likely to consume non-alcoholic beer. Designing specific vessels to enhance the positive characteristics of non-alcoholic beer would ease the transition from alcoholic to non-alcoholic products. Also, it is important to remark that conducting cross-cultural studies would increase knowledge on understanding whether some cultures are more sensitive to specific tactile stimuli, or specific multimodal association strategies.

Informing consumers that the sample they were drinking was a non-alcoholic beer ("information" factor) did not have an effect on liking or the perception of the different attributes of the samples. These outcomes are not in concordance with the ones reported by Silva et al. [9] who reported that consumers liked non-alcoholic beer more when it was labeled as alcoholic beer. No information was provided to consumers in the NI condition, preventing the creation of expectations and allowing them to think that the beer they were drinking could be an alcoholic or low-alcohol sample. The results of the present study showed no significant differences in the assessed attributes or liking when consumers were aware that they were drinking non-alcoholic beer, but a trend in emotions elicited by the I vs. NI conditions was observed, suggesting that consumers were pleased when they had some information about the characteristics of the sample. Non-alcoholic beers have been reported to evoke neutral and negative emotional responses, such as rational, conscious, and disappointed [33]. Emotional responses observed in the present study

were in concordance with these results, with the NA sample being closely related to more negative emotions if compared with the A sample.

Contrary to what was expected, using a ceramic vessel with a different visual appearance than the other three glasses did not significantly affect the perception of the sensory attributes of the samples. Piqueras-Fiszman and Spence [34] showed that the color of the cups influenced the perception of hot chocolate drinks. Also, the color of the beer has been reported to influence beer perception [9,35], but drinking from a ceramic glass that hid the color of the samples served in the present study did not impact the perception of their main attributes, having only an influence on the liking of the NA sample. It is possible that liking was higher when the sample was drunk from the plain glass because the appearance attributes of the NA beer significantly contributed to increasing its acceptance, and the plain glass was the one in which the visual characteristics of the sample were best appreciated. Having information on which of the sensory modalities of a beer are drivers of its acceptance is essential to designing bottles or glasses to favor product selection, and this study adds interesting information to this field of knowledge.

5. Conclusions

The results of this study added new information to the existing research about cross-modal relationships between the haptic information received from the glass and the organoleptic sensations generated by the product. This study revealed that the texture of the glass did not affect the perception of different attributes of beer, although they affected liking in a non-alcoholic beer sample. The study also found that people generally associate beer with alcohol with positive emotions, while beer without alcohol is associated with unpleasant emotions. The possibility of reintroducing a ceramic recipient for beer drinking in the current scenario was seen as feasible, not from the point of view of it changing the perception of the attributes of the beer, but rather as a differentiating factor of the beer brand, restaurant, or bar in which the product is served. While feasible, it is important to consider the importance that appearance has as a determinant of liking or specific product selection, as the use of ceramic glass had an impact on liking in one of the studied beer samples.

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