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Original Article

Sensory, situational, and food pairing characterisation of craft beer

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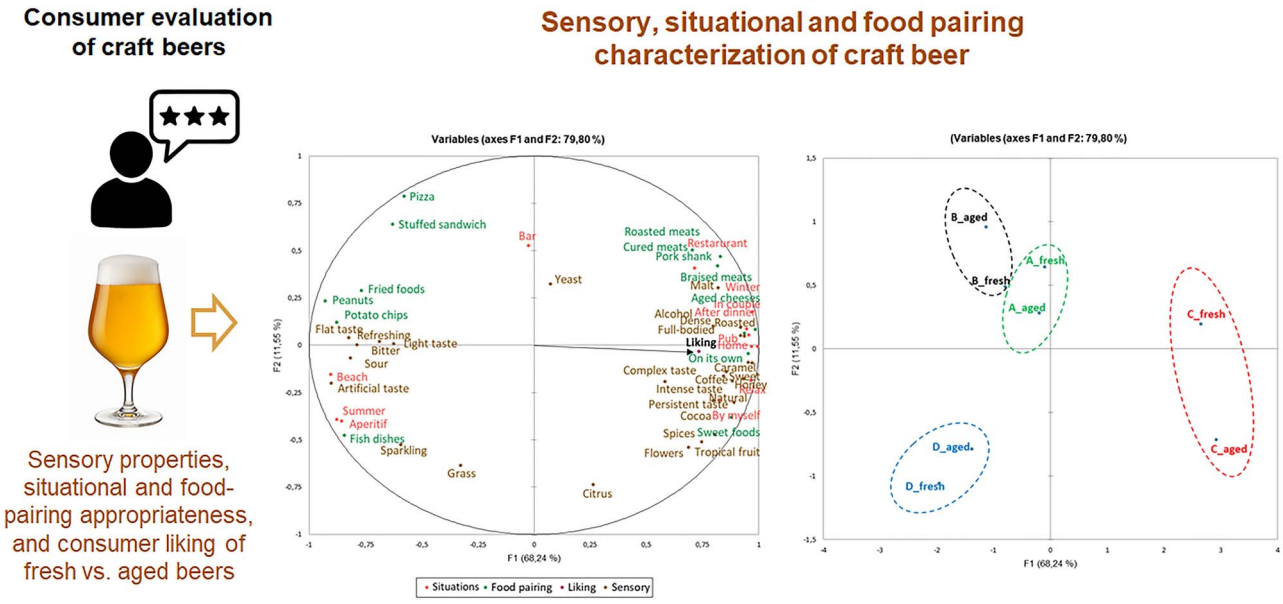
Abstract

This study employed the Global Profile method, a multidimensional sensory evaluation tool, to characterise craft beers from Tuscan artisanal breweries. The approach was expanded beyond conventional sensory attributes to include consumption situations and food-pairing appropriateness, offering a more holistic understanding of each beer's distinctive profile. Results describe how flavour, aroma, and texture are associated with situational and pairing associations, highlighting the unique sensory signatures that distinguish artisanal beers. To assess storage effects, beers were evaluated under two conditions: cold storage, representing fresh (T0), and warehouse storage for 1 year, representing aged samples. Comparison showed that sensory profiles remained largely stable, with only minor variations in attribute intensity and situational appropriateness, which did not impact on overall liking. Findings demonstrate the value of integrating sensory, situational, and pairing measures to capture the complexity of craft beer perception and provide practical insights for brewers seeking to refine product positioning and sustain consumer satisfaction.

Keywords: global profile, liking, consumer experience, artisanal breweries, storage conditions

Graphical abstract



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Introduction

In recent years, the popularity of craft beer has grown rapidly, fuelled by consumer demand for authenticity, distinctiveness, and high-quality products (Cabras et al., 2016; Carroll & Swaminathan, 2000; Gómez-Corona et al., 2016). This trend reflects a broader shift in consumer values, with increasing interest in sustainability, local identity, and artisanal production methods (Holtkamp et al., 2016; Salanță et al., 2020). Typically brewed in small batches using traditional techniques and unconventional ingredients, craft beers offer distinctive sensory profiles that set them apart from mass-produced alternatives (Acitelli & Magee, 2017; Atallah et al., 2021; Baiano, 2021; Capece et al., 2018; Martínez et al., 2017).

However, the appeal of craft beer extends beyond its flavour. Consumption is often embedded within broader sensory and situational experiences, including choices about when, where, and with whom the beer is enjoyed, as well as which foods it is paired with (Baiano, 2021; Donadini et al., 2015). The act of drinking craft beer has thus become a rich, multifaceted experience, involving situational dimensions that conventional sensory evaluation may overlook.

To better capture this complexity, the Global Profile approach was proposed as a multidimensional tool that integrates sensory perception and the situation of consumption (Spinelli et al., 2019; Pierguidi et al., 2019, 2020a). Unlike traditional hedonic methods, this approach investigates how consumers engage with a product across multiple experiential dimensions, offering a deeper understanding of product perception and usage. In the context of craft beer, where appropriateness in specific situations plays a central role in consumer satisfaction, the Global Profile approach holds particular relevance.

Despite this, one important experiential aspect remains underexplored: culinary pairing. Food-beverage pairing is a key component of the craft beer experience, influencing sensory evaluation (Donadini et al., 2015; Lahne, 2019). Yet, the food-beverage pairing dimension, to the best of our knowledge, has never been integrated into broader sensory-situational frameworks. Extending the Global Profile approach to include food pairing could thus provide a more comprehensive understanding of the beer experience, with implications for both sensory science and marketing strategies.

At the same time, a critical challenge for the craft beer industry is the stability of sensory properties over time. Craft beers, often unfiltered and unpasteurised, are more susceptible to chemical and sensory changes during storage (Aguiar et al., 2022; Baiano, 2021). Although these changes may not compromise safety, they can affect key attributes, such as aroma, flavour, and mouthfeel before quality thresholds are breached (Hough et al., 2006). This discrepancy between expected and perceived quality may undermine consumer trust (Costell, 2002), particularly in a segment where experience and authenticity are central to perceived value (Bamforth & Lentini, 2009).

While trained sensory panels are typically used to monitor shelf-life and quality changes (Bishop & White, 1986; Lee & Chambers, 2010), their evaluations may not reflect how consumers experience these changes in real-world contexts. Consumer perception is shaped by more than isolated sensory inputs: it involves situational relevance, and expectations (King & Meiselman, 2010; Meiselman, 2013; Spinelli et al., 2019; Thomson, 2010). Moreover, overall liking may remain stable even when situational fit or pairing preferences shift due to changes in the product's sensory profile (Mustonen et al., 2007).

The present study aimed at describing consumer experience with craft beers. The Global Profile approach was extended to integrate situational appropriateness and food pairings with sensory description of craft beers. In addition, the temporal stability of the performance of craft beers was assessed by comparing consumer experience with fresh products and with those stored for 1 year.

Materials and methods

Experimental design: overview

To explore how consumers experience craft beer across sensory, situational, and food pairing dimensions, and to assess how this experience may change due to long-term storage, a two-phase study was conducted.

In the first phase, a product-specific Global Profile questionnaire was developed based on the framework by Spinelli et al. (2019), which captures the multidimensional nature of consumer experience. To extend this framework to food and beverage pairing, an online test was conducted with craft beer consumers. Participants provided sensory descriptions of craft beer using a modified repertory grid method (RGM) (Spinelli et al., 2014) and answered open-ended questions about preferred consumption situations and food pairings. Their responses were then used to create a structured Global Profile questionnaire that captures both descriptive and evaluative aspects of the craft beer experience.

The second phase of the study was conducted using a reversed storage design, in which half of each beer batch was preserved under conditions that prevented modifications, while the other half was stored under conditions that allowed changes to develop (Hough, 2010). This design is particularly suited to craft beers, where batch-to-batch variability prevents direct comparison of independent batches, and it ensures that observed differences can be attributed to storage rather than production variability, while allowing all sensory evaluations to be carried out in a single session, minimising contextual distortions (Giménez et al., 2012; Hough, 2010). In the particular type of reverse design chosen here half of the batch was stored from one single batch under conditions that stop all deterioration processes (Giménez & Ares, 2019) which, in the case of the beer has been considered to be 6 °C, minimising chemical and sensory alterations (Aguiar et al., 2022; Valentoni et al., 2022). This sample was considered as "fresh," mimicking the case of a beer at t0 (Paternoster et al., 2020). Half batch was instead preserved under normal conditions until their evaluation warehouse storage at 14–25 °C in dark conditions, simulating typical distribution environments where sensory changes could occur, serving as the "aged" condition.

Four craft beers, packaged in 33 cl amber glass bottles, were selected from local breweries and each was assigned to two storage conditions: "fresh" and "aged," and storage lasted 1 year in both conditions, corresponding to the best-before date indicated by the breweries and reflecting real-world distribution and retail conditions (Aguiar et al., 2022).

After storage, consumers attended the Sensory Laboratory of the University of Florence (Italy) to evaluate the beers using the previously developed Global Profile questionnaire. Following the reversed storage design, each participant tasted all four beers under both storage conditions ("fresh" and "aged"), enabling direct comparisons between fresh and aged versions. Evaluations included overall liking, perceived sensory characteristics, appropriateness of consumption situations, and food pairing preferences.

Participants

In the initial phase of the study, which focused on developing a product-specific Global Profile questionnaire, 241 craft beer consumers (consuming craft beer at least twice a month) participated. The sample had a mean age of 35.2 ± 11.5 years, with 47% women. In the second phase, which involved a consumer tasting session of fresh and aged beer samples, 81 regular consumers (45% women, consuming beer at least twice a month) took part, with a mean age of 40.3 ± 13.8 years.

All participants were recruited in the Florence area (Tuscany, Italy) through online advertising. Approval from an ethics committee was not required under national regulations. Researchers complied with the Ethics and Standards for Sensory Project Managers issued by the Italian Sensory Science Society. All participants provided written informed consent in accordance with the General Data Protection Regulation (GDPR) 2016/679 and were free to withdraw at any time without justification. All tested products were confirmed safe for consumption, and participants involved in the craft beer tasting received a gift card as compensation.

To monitor panellists' blood alcohol content and comply with Italian drink-drive limits (0.5 g/L), Widmark's formula (Widmark, 1981) was applied, factoring in gender, weight, and age based on the total alcohol content of the samples. Calculations showed that even for participants with lower body weight (e.g., 50 kg) and female sex (factors associated with higher alcohol sensitivity) the total consumption of 120 ml of beer (15 ml from each of the eight samples) kept the estimated blood alcohol content below legal limits. As a precaution, participants were informed before the test that, according to this calculation, even a female participant weighing 50 kg would not exceed the legal blood alcohol limit.

Craft beer selection

The beers were selected to represent a range of distinctive profiles within blonde and pale ales, differing in style, flavour, and alcohol content. Four beers from professional craft breweries in Tuscany, Italy, were chosen, all with high-quality production and at least 51% self-produced ingredients. According to the breweries' descriptions, Beer A, a pale Belgian Saison (6% alcohol), was spicy and vegetal with a bitter finish. Beer B, a golden ale (4.5% alcohol), was light-bodied, easy-drinking, and subtly fruity. Beer C, a seasonal Pale Ale (4.6% alcohol), was floral and balanced with notes of honey and citrus. Beer D, a blonde ale (4.6% alcohol), was smooth and refreshing with light malt and subtle fruit flavours. This selection provided clear contrasts in aroma, flavour, and body, allowing exploration of consumer responses across diverse sensory profiles.

Development of a Global Profile questionnaire for sensory, situational, and food-pairing characterisation of craft beers

To develop a product-specific questionnaire for the evaluation of sensory characteristics, consumption situations and beer-food pairing appropriateness of craft beers, a qualitative online test was conducted using the Global Profile approach (Spinelli et al., 2019). The survey was self-administered and structured using a modified RGM, with a series of open-ended questions. Responses collected during this phase were analysed following a semiotic framework, as adopted in previous studies on sensory-emotional characterisation (Spinelli et al., 2019) and context appropriateness (Pierguidi et al., 2020a). For the present study, the Global Profile methodology was extended to include the description of foods considered suitable for pairing with beers.

The online questionnaire began with a RGM in which participants were asked to rank three beer types (industrial, craft, and abbey) according to personal preference. Subsequently, participants described how each beer type differed from the others in terms of sensory properties such as appearance, taste, flavour, and aroma. This comparative task was designed to elicit spontaneously generated descriptors and associations for craft beer. Next, participants were invited to imagine enjoying their favourite beer and describe the ideal situation including the time, place, social setting, and other meaningful environmental cues following a procedure consistent with previous research (Hein et al., 2012; Spinelli et al., 2017; Pierguidi et al., 2020b). Finally, with an open-ended question, participants were asked to list foods they typically enjoyed pairing with their favourite beer. The structure and the questions of this qualitative survey are provided in Supplementary Material.

A total of 241 responses were collected and analysed using a semiotic methodology (Greimas et al., 1982; Rastier & Riemer, 2015; Violi, 2001). The goal was to extract meaningful sensory descriptors, relevant consumption situations, and culturally rooted food-pairing associations from participants' narratives. This analysis, supervised by an experienced semiotician (PhD), involved identifying recurring semantic units, grouping terms with similar meanings into semantic categories, and mapping their relationships, such as oppositions or complementarities (Greimas et al., 1982; Spinelli & Monteleone, 2018).

Although all 241 responses contributed to the richness of the dataset, thematic saturation, defined as the point at which no new meaningful semantic categories emerged, was reached after approximately 40 participants suggesting that this number may be sufficient when the interest is selecting items to be used in a further study. The emergent semantic categories were reformulated into concise statements, enabling the construction of three product-specific sub-questionnaires.

After semiotic analysis, distinctive semantic categories were identified for each domain: 29 sensory properties, 15 situations, and 20 beer-food pairings. The final questionnaire was structured in three sections. The sensory evaluation section asked consumers, "How do you find the beer you have just tasted?," requiring intensity ratings of taste, aroma, flavour, and mouthfeel descriptors. The situation appropriateness section asked, "How appropriate do you find the beer you have tasted for each of these situations?," while the food-pairing section asked, "How suitable do you find the beer you have just tasted for pairing with each of these foods?" The full list of items used in each section is reported in Table 1.

Craft beer tasting session

Following the reversed design approach, the craft beer tasting was conducted in a single session, during which eight samples were evaluated: four fresh craft beers and the same four beers aged after 1 year of warehouse storage. Craft beer samples, identified by three-digit randomised numbers, were served in 100 ml glasses at 10 °C, each containing 15 ml of beer. Each beer was tasted within 10 min of sample preparation to maintain sensory properties (e.g., carbonation). Block randomisation was applied, with samples presented in four blocks (one for each beer), each containing one fresh and one aged sample of the same beer. This was executed through a fully-randomised and balanced design. Consumers rated their liking of craft beers using a 9-point hedonic scale (Peryman & Pilgrim, 1957). Additionally, they evaluated the intensity of sensory properties, situations, and food pairing appropriateness through the developed product-specific

Table 1. Questionnaire items used for the evaluation of craft beers.

Sensory properties	Context appropriateness	Beer–food pairing appropriateness
"How do you find the beer you have just tasted?"	"How appropriate do you find the beer you have tasted for each of these situations?"	"How suitable do you find the beer you have tasted for pairing with each of these foods?"
1. It is sweet	1. With friends	1. With pizza
2. It is bitter	2. In couple	2. With fresh cheeses
3. It is sour	3. By myself	3. With aged cheeses
4. It has an intense taste	4. When I want to relax	4. To drink on its own
5. Tastes like hops	5. In a bar	5. With cured meats
6. Has a persistent taste	6. In a pub	6. With grilled meats
7. Tastes like spices	7. In summer	7. With roasted meats
8. Tastes like malt	8. At the beach	8. With braised meats
9. Tastes like citrus	9. In winter	9. With a stuffed sandwich
10. It is alcoholic	10. After dinner	10. With pasta dishes
11. Tastes like honey	11. During dinner	11. With fish dishes
12. Tastes like roasted	12. As an aperitif before dinner	12. With vegetables
13. Tastes like coffee	13. At home	13. With fruit
14. Tastes like caramel	14. At the restaurant	14. With sweet foods
15. Tastes like cocoa	15. At a party	15. With spicy foods
16. Tastes like tropical fruit		16. With peanuts
17. Tastes like flowers		17. With olives
18. It is full-bodied		18. With pork shank
19. It is dense		19. With potato chips
20. Has a light taste		20. With various fried foods (potatoes, *etc.*)
21. It is sparkling		
22. Has an artificial taste		
23. Tastes like grass		
24. Tastes like yeast		
25. It is puckering		
26. Has a complex taste		
27. Has a flat taste		
28. Gives me the idea of naturalness		
29. It is refreshing		

Note. The table lists all items included in the sensory properties, context appropriateness, and beer–food pairing sections, with sentences presented to participants.

questionnaire, which utilised 7-point Likert scales (1 = not at all; 7 = very much). Following each sample (and each block), a 90-s break was incorporated, accompanied by palate cleansers such as water and plain crackers.

Data analysis

To evaluate the differences in overall liking between fresh and aged samples, three-way mixed-model ANOVAs were employed. Fixed factors included sample and storage conditions ("fresh" or "aged"), with consumers considered as a random factor (Næs et al., 2011). Two-way interactions between fixed factors were considered, and Tukey's Honestly Significant Difference (HSD, Abdi & Williams, 2010) was applied for *post-hoc* comparisons of means, where significant effects were detected.

To comprehensively explore the relationships among liking, sensory data, situation, and beer-food pairing appropriateness across different storage conditions, a multiple factor analysis (MFA) (Escofier & Pages, 1994) was conducted. The four beers under both storage conditions (fresh and aged) resulted in eight different samples, which were considered along with three product domains: sensory, situation, and food-pairing, serving as the main MFA data blocks. Liking was included as a supplementary variable. The dataset consisted of averaged data across samples, and only attributes showing significant discrimination between samples ($p < .05$), were included in the analysis.

The data analysis was performed using the XLSTAT statistical software (Lumivero, version 2023.3).

Results

Consumer liking

Significant differences in liking were observed among samples ($F_{(3,80)} = 11.34$, $p < .0001$). All samples received positive evaluations above the mean point of the scale, with Sample C (mean liking = 6.6) being the most preferred, followed by Samples B (mean liking = 6) and A (mean liking = 5.9). Sample D (mean liking = 5.6) was not significantly different from Sample A. Neither the main effect of storage condition nor its interaction with sample was significant ($p > .05$), demonstrating that 1 year of storage under controlled conditions did not alter consumer hedonic perception.

Sensory attributes, situation, and beer-food pairing appropriateness

The extended Global Profile approach successfully captured distinct and meaningful product signatures for each beer, with nearly all sensory attributes significantly discriminating among samples ($p < .05$; Table 2). The beers exhibited distinct sensory profiles that were consistent with the characteristics described by the producers. Beer A (Pale Belgian Saison, 6% alcohol) showed higher bitterness and more persistent taste compared to Beer B and D, consistent with its description as a beer with a bitter finish. Beer B (Golden Ale, 4.5% alcohol) was lighter in body than Beers A and C, consistent with its description as an approachable golden ale. Beer C (Seasonal Pale Ale, 4.6% alcohol) exhibited higher sweetness, spiciness, complexity, and floral/fruity notes than all other beers, consistent with its description as a floral and

Table 2. Three-way ANOVA with interaction (sample × storage condition) for "fresh" and "aged" craft beers.

Sensory properties	Samples				*p*-value		
	Beer A	Beer B	Beer C	Beer D	Sample	Storage condition	Sample∗Storage condition
Sweet	2.41^{b}	2.50^{b}	3.49^{a}	2.34^{c}	**<.0001**	.318	.193
Bitter	4.56^{a}	4.00^{b}	3.47^{c}	4.46^{a}	**<.0001**	.093	.792
Sour	3.44^{a}	3.05^{b}	2.65^{c}	3.42^{a}	**<.0001**	.962	.391
Intense taste	4.43^{a}	3.76^{b}	4.72^{a}	3.98^{b}	**<.0001**	.104	.988
Hops	4.18	4.02	3.98	4.03	.381	.216	.190
Persistent taste	4.48^{a}	3.85^{b}	4.52^{a}	4.15^{ab}	**<.0001**	.659	.119
Spices	2.98^{b}	2.74^{b}	3.55^{a}	3.05^{b}	**<.0001**	.703	.627
Malt	4.10^{ab}	3.93^{ab}	4.21^{a}	3.79^{b}	**.003**	.444	.457
Citrus	3.05^{a}	2.48^{b}	3.21^{a}	3.27^{a}	**<.0001**	.898	.536
Alcohol	4.30^{a}	3.88^{b}	4.36^{a}	3.78^{b}	**<.0001**	.362	.380
Honey	2.46^{b}	2.67^{b}	3.64^{a}	2.56^{b}	**<.0001**	.535	.697
Roasted	2.79^{b}	2.85^{b}	3.27^{a}	2.71^{b}	**.000**	.706	.718
Coffee	1.78^{b}	1.85^{b}	2.25^{a}	1.80^{b}	**<.0001**	.301	.235
Caramel	2.33^{b}	2.32^{b}	3.24^{a}	2.15^{b}	**<.0001**	.390	.790
Cocoa	1.54^{b}	1.72^{b}	2.15^{s}	1.69^{b}	**<.0001**	.121	.319
Tropical fruit	2.21^{b}	2.17^{b}	2.76^{a}	2.38^{b}	**<.0001**	.738	.324
Flowers	2.92^{ab}	2.56^{b}	3.26^{a}	2.92^{ab}	**<.0001**	.656	.398
Full-bodied	3.72^{b}	3.15^{c}	4.15^{a}	3.07^{c}	**<.0001**	.494	.405
Dense	3.35^{b}	2.79^{c}	3.72^{a}	2.75^{c}	**<.0001**	.398	.435
Light taste	3.30^{b}	3.95^{a}	3.30^{b}	3.73^{ab}	**.000**	.789	.615
Sparkling	3.80^{b}	3.30^{c}	3.28^{c}	4.20^{a}	**<.0001**	**.013**	.210
Artificial taste	2.99^{a}	3.06^{a}	2.57^{b}	3.31^{a}	**<.0001**	.922	.430
Grass	2.62^{b}	2.39^{b}	2.55^{b}	2.96^{a}	**.000**	**.015**	**.026**
Yeast	3.61^{a}	3.26^{b}	3.36^{ab}	3.32^{b}	**.008**	.080	.162
Puckering	2.67	2.51	2.72	2.63	.483	.686	.454
Complex taste	3.97^{b}	3.53^{c}	4.40^{a}	3.54^{c}	**<.0001**	.840	.581
Flat taste	2.65^{b}	3.22^{a}	2.42^{b}	3.11^{a}	**<.0001**	.072	.377
Natural	3.87^{b}	3.70^{b}	4.32^{a}	3.78^{b}	**<.0001**	.624	.412
Refreshing	3.76^{b}	4.19^{a}	3.79^{b}	4.09^{ab}	**.007**	.167	.950

Note. Means are shown for the sample factor only. *p*-values for each sensory attribute are reported. Significant differences are highlighted in bold ($p < .05$), and different letters ($^{a–c}$) in row indicate significant differences according to Tukey's *post hoc* test for the sample factor.

balanced pale ale. Beer D (Blonde Ale, 4.6% alcohol) had higher herbal/grass notes and a more sparkling mouthfeel than Beers A, B, and C, consistent with its description as a refreshing blonde ale with subtle fruit flavours.

These distinct sensory profiles directly translate into specific consumer usage contexts (Table 3). Beer C, the most liked sample, was judged more appropriate than all other beers for multiple situations, including relaxed or individual consumption, after dinner, at home, in winter, and at the pub, as well as for pairings with aged cheeses. In contrast, Beers A and B were considered more appropriate than Beer C for casual social situations, including pizza (Table 4) and "aperitivo," whereas Beer D was considered more appropriate than Beer A and C for beach occasions. This clear difference demonstrates that sensory properties are the primary drivers of situational and food-pairing appropriateness.

The most significant finding regarding storage was the remarkable stability of the product experience. A significant main effect of storage condition was only found for sparkling mouthfeel, indicating higher intensity for "aged" samples as compared to the "fresh" ones (Table 2). Significant interaction effects were observed for grassy flavour perception. *Post hoc* tests revealed that, for Beer D, the aged sample was perceived as less grassy compared to the "fresh" one. No other significant differences between fresh and aged samples were observed for any of the other beers or attributes.

No main effect of storage condition was found for situation appropriateness. A significant interaction effect emerged for the appropriateness of beers consumed "by myself" (Table 3), although these differences were not supported by *post hoc* tests.

The first two dimensions of the MFA explained 79.80% of the variance. The MFA score plot revealed clear differentiation among the four craft beer samples, with each occupying distinct regions in the multidimensional space. "Fresh" and "aged" versions of each beer were located closely together, indicating that storage conditions had minimal impact on the overall sensory, situational, and food-pairing profiles. Only for Beer C, we can see a larger difference between the two storage conditions, along the second dimension, with the "fresh" version more described by malt notes and the "aged" version more characterised by fruity and flower notes (Figure 1).

From left to right along F1, Beer D occupied the far-left position, reflecting contrasting sensory and situational characteristics compared with Beer C, which was positioned on the far-right, strongly associated with F1 and overall liking. Beer D was primarily associated with a sparkling mouthfeel and distinctive sensory notes, notably artificial and grassy flavours. Its situational associations were oriented towards seasonal and casual situations, such as summer, the beach, and aperitifs, while its food-pairing profile was associated with fish dishes.

Beer C exhibited a rich and persistent sensory profile, including roasted, cocoa, spices, floral, and tropical fruit notes, along with a dense, full-bodied mouthfeel. It was associated with at-home and post-dinner consumption, intimate settings with a partner, and pub environments. Its food-pairing associations included aged

Table 3. Three-way ANOVA with interaction (sample × storage condition) for "fresh" and "aged" craft beers.

Contexts	Samples				*p*-value		
	Beer A	Beer B	Beer C	Beer D	Sample	Storage condition	Sample*Storage condition
With friends	4.82^{ab}	4.80^{b}	5.00^{a}	4.72^{b}	.267	.958	.982
In couple	4.22^{b}	4.05^{b}	4.55^{a}	3.93^{b}	**.001**	.534	.943
By myself	3.84^{b}	3.63^{b}	4.33^{a}	3.75^{b}	**.000**	.995	**.040**
Relax	3.71^{b}	3.57^{b}	4.38^{a}	3.60^{b}	**<.0001**	.586	.937
Bar	4.33	4.37	4.33	4.28	.938	.108	.378
Pub	4.82^{b}	4.54^{b}	5.41^{a}	4.51^{b}	**<.0001**	.742	.494
Summer	4.24^{b}	4.28^{ab}	4.01^{b}	4.68^{a}	**.001**	.796	.873
Beach	3.66^{bc}	3.96^{ab}	3.38^{c}	4.17^{a}	**<.0001**	.451	.350
Winter	4.24^{b}	3.90^{bc}	4.76^{a}	3.61^{c}	**<.0001**	.959	.871
After dinner	4.02^{b}	3.94^{b}	4.55^{a}	3.83^{b}	**<.0001**	.894	.410
During dinner	4.09	4.00	4.05	3.83	.363	.590	.921
Aperitif	3.74^{ab}	3.89^{ab}	3.59^{b}	4.11^{a}	**.029**	.553	.942
Home	4.18^{b}	4.07^{b}	4.60^{a}	3.96^{b}	**.000**	.606	.959
Restaurant	3.93^{a}	3.71^{a}	3.95^{a}	3.59^{a}	**.046**	.751	.774
Party	4.31	4.39	4.24	4.30	.826	.884	.537

Note. Means are shown for the sample factor only. *p*-values for each situational attribute are reported. Significant differences are highlighted in bold ($p < .05$), and different letters ($^{a–c}$) in a row indicate significant differences according to Tukey's *post hoc* test for the sample factor.

Table 4. Three-way ANOVA with interaction (sample × storage condition) for "fresh" and "aged" craft beers.

Beer-food pairings	Samples				*p*-value		
	Beer A	Beer B	Beer C	Beer D	Sample	Storage condition	Sample*Storage condition
Pizza	4.45^{a}	4.59^{a}	4.04^{b}	4.20^{ab}	**.001**	.863	.795
Fresh cheeses	3.51	3.75	3.63	3.75	.307	.820	.984
Aged cheeses	3.90^{b}	3.97^{b}	4.37^{a}	3.79^{b}	**.001**	.372	.739
On its own	4.24^{b}	4.31^{b}	4.90^{a}	4.17^{b}	**<.0001**	.947	.818
Cured meats	4.10^{ab}	4.25^{ab}	4.39^{a}	3.92^{b}	**.007**	.633	.243
Grilled meats	4.03	4.03	4.04	3.74	.157	.417	.208
Roasted meats	3.85^{ab}	3.84^{ab}	4.06^{a}	3.53^{b}	**.006**	.376	.908
Braised meats	3.20^{b}	3.16^{ab}	3.56^{a}	3.02^{b}	**.003**	.891	.893
Stuffed sandwich	4.50^{a}	4.56^{ab}	4.16^{b}	4.35^{ab}	**.028**	.349	.603
Pasta dishes	3.04	3.10	2.88	3.01	.332	.839	.213
Fish dishes	2.65^{ab}	2.64^{ab}	2.47^{b}	2.91^{a}	**.019**	.899	.857
Vegetables	3.02	3.13	3.03	3.22	.403	.358	.865
Fruit	2.07	2.06	2.12	2.31	.132	.482	.889
Sweet foods	2.08^{b}	2.02^{b}	2.42^{a}	2.10^{ab}	**.009**	.756	.576
Spicy foods	3.75	3.61	3.69	3.79	.618	.601	.716
Peanuts	4.69^{a}	4.72^{ab}	4.36^{b}	4.75^{a}	**.017**	.886	.704
Olives	4.24	4.23	4.17	4.21	.968	.426	.416
Pork shank	4.03^{bc}	3.83^{ab}	4.27^{a}	3.55^{c}	**.000**	.985	.292
Potato chips	4.61^{a}	4.64^{ab}	4.29^{b}	4.74^{a}	**.006**	.470	.209
Fried foods	4.65^{ab}	4.57^{a}	4.27^{b}	4.62^{ab}	**.033**	.610	.189

Note. Means are shown for the sample factor only. *p*-values for each food pairing attribute are reported. Significant differences are highlighted in bold ($p < .05$), and different letters ($^{a–c}$) in a row indicate significant differences according to Tukey's *post hoc* test for the sample factor.

cheeses, braised meats, sweet dishes, and options for drinking on its own.

Beer B was located centrally along F1 and moderately upward along F2, capturing subtler variations in sensory attributes and situational appropriateness. It was associated with social and casual situations, such as bars and informal gatherings, and its best food pairings included pizza and stuffed sandwiches.

Beer A was positioned towards the centre-left of F1 and the lower portion of F2, showing low representation in the model. It was moderately associated with milder sensory attributes and general situational suitability, lacking distinctive characteristics or strong food-pairing associations.

This visual representation strongly supports the conclusion that the core identity of each beer, defined by its integrated sensory, situational, and food-pairing profile, was preserved over time.

Discussion

In this study, we adopted a multidimensional approach to obtain a holistic evaluation of craft beers, considering not only their sensory profiles but also their situational and food-pairing appropriateness. Central to this, methodology was the use of a product-specific questionnaire developed through the Global Profile approach (Spinelli et al., 2019), based on an online version of the RGM with open-ended questions. This tool proved effective in capturing multiple facets of the consumer experience,

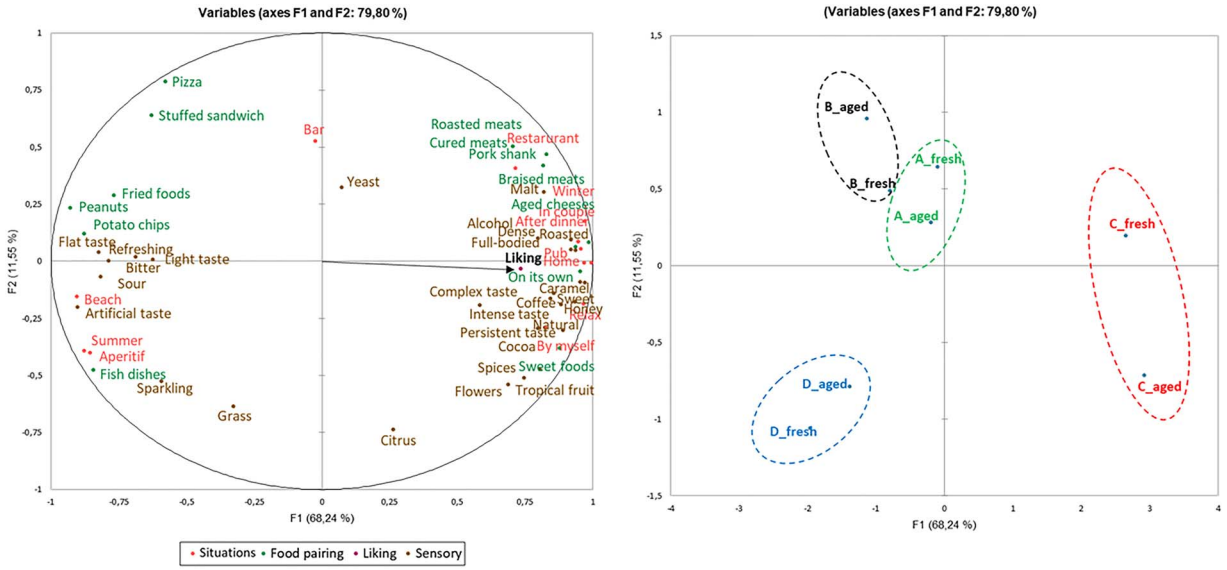

Figure 1. Correlation circle and score plot of the first and second dimensions from the multiple factor analysis, illustrating the positioning of four beers (A, B, C, and D) in both fresh and aged conditions. The liking variable (in bold) is shown as a supplementary variable.

including sensory properties, hedonic responses, consumption situations, and perceived suitability for food pairings.

The Global Profile approach highlighted clear differentiation among the craft beer samples, with each occupying distinct positions in the multidimensional space. Storage conditions ("fresh" vs. "aged") had little influence, as paired versions of the same beer were closely positioned, indicating that sensory, situational, and food-pairing characteristics primarily drove sample differentiation. Overall, the beers demonstrated very little difference over the two conditions, confirming that controlled storage preserves their core sensory identity and supports reliable best-before dates.

Across the dataset, contrasts were observed between beers with rich, complex sensory profiles and those with a lighter profile. Samples with intense, full-bodied, and multifaceted sensory characteristics were typically associated with relaxed or intimate consumption situations, such as at-home and post-dinner occasions, and versatile food pairings, including aged cheeses, braised meats, sweet dishes, or options for drinking on their own. Beers with lighter or sparkling sensory profiles were linked to seasonal or casual situations, such as summer, the beach, and aperitifs, and were generally paired with lighter foods, including fish dishes. Intermediate samples exhibited mixed associations, reflecting social or casual consumption situations and familiar comfort foods, highlighting the spectrum of consumer experiences across craft beer styles. These patterns indicate that differentiation among beers is primarily driven by sensory properties which relate to specific situational, and food-pairing appropriateness (Cardello et al., 2016; King & Meiselman, 2010), with storage conditions that overall do not impact the consumer experience.

Examining sensory stability over time is particularly relevant for breweries, as it helps establish boundaries within which sensory changes are likely to occur, thereby safeguarding consumer expectations and brand consistency (Labuza & Schmidl, 1988). A key strength of the proposed approach was the reversed evaluation design, which allowed simultaneous assessment of beers stored under different conditions within a single session. This design minimises potential biases arising from seasonal variation, batch differences, or panel inconsistencies (Hough et al., 2006; Hough & Garitta, 2012), and, when combined with the multidimensional questionnaire, provides a cost-effective and consumer-friendly tool for evaluating complex product experiences. The results also emphasise the importance of involving consumers directly in quality monitoring (Costell, 2002; Giménez et al., 2012; Hough et al., 2006), as this ensures that subtle variations in sensory perception and situation appropriateness are detected, preventing potential declines in satisfaction and loyalty.

Overall, the study demonstrates that consumer perception of craft beers is largely defined by the interplay of sensory complexity, situational suitability, and food-pairing potential. The Global Profile approach provides breweries with a powerful, flexible method to capture these associations, informing product development, marketing strategies, and quality monitoring, and supporting innovation in the increasingly competitive craft beer market (Aguiar et al., 2022; Stewart, 2016).

Conclusion

This study demonstrated that the Global Profile methodology is a powerful tool for holistic characterisation of craft beers by integrating sensory properties with situational appropriateness and food-pairing. The approach clearly differentiated beers based on their inherent sensory profiles, revealing that complex, full-bodied beers were associated with relaxed, post-dinner occasions, and foods rich in flavour, while lighter beers were linked to casual, social situations, and lighter dishes.

Furthermore, the research indicated that under controlled storage conditions the core sensory identity and consumer perception of the beers remained stable over 1 year. This confirms the validity of best-before dates and underscores that a beer's sensory profile is the primary driver of consumer experience. This stability provides breweries with confidence in their quality control and product shelf-life.

In summary, the Global Profile method offers the industry a comprehensive, consumer-centred framework to guide product development, quality assurance, and targeted marketing, ultimately helping breweries protect their brand identity and innovate in a competitive market.

Author contributions

Lapo Pierguidi (Conceptualisation, Methodology, Validation, Formal analysis, Investigation, Data curation, Writing—original draft, Visualisation), Sara Spinelli (Conceptualisation, Methodology, Writing—review & editing), Erminio Monteleone (Conceptualisation, Methodology, Writing—review & editing), and Caterina Dinnella (Conceptualisation, Methodology, Writing—review & editing, Supervision, Project administration, Funding acquisition)

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Conflicts of interest

None declared.

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References

Abdi, H., & Williams, L. J. (2010). Tukey's honestly significant difference (HSD) test. *Encyclopedia of Research Design*, 3, 1–5.

Acitelli, T., & Magee, T. (2017). *The audacity of hops: The history of America's craft beer revolution*. Chicago Review Press.

Aguiar, D., Pereira, A. C., & Marques, J. C. (2022). The influence of transport and storage conditions on beer stability—A systematic review. *Food and Bioprocess Technology*, 15, 1477–1494. https://doi.org/10.1007/s11947-022-02790-8

Atallah, S. S., Bazzani, C., Ha, K. A., & Nayga, R. M. (2021). Does the origin of inputs and processing matter? Evidence from consumers' valuation for craft beer. *Food Quality and Preference*, 89, 104146. https://doi.org/10.1016/j.foodqual.2020.104146

Baiano, A. (2021). Craft beer: An overview. *Comprehensive Reviews in Food Science and Food Safety*, 20, 1829–1856. https://doi.org/10.1111/1541-4337.12693

Bamforth, C. W., & Lentini, A. (2009). The flavor instability of beer. In C. W. Bamforth (Ed.), *Beer: A quality perspective* (pp. 85–109). Academic Press. https://doi.org/10.1016/B978-0-12-669201-3.00003-8

Bishop, J. R., & White, C. H. (1986). Assessment of dairy product quality and potential shelf-life—A review. *Journal of Food Protection*, 49, 739–753. https://doi.org/10.4315/0362-028X-49.9.739

Cabras, I., Higgins, D., & Preece, D. (Eds.) (2016). *Brewing, beer and pubs: A global perspective*. Palgrave Macmillan. https://doi.org/10.1057/9781137466181

Capece, A., Romaniello, R., Pietrafesa, A., Siesto, G., Pietrafesa, R., Zambuto, M., & Romano, P. (2018). Use of *Saccharomyces cerevisiae* var. Boulardii in co-fermentations with *S. cerevisiae* for the production of craft beers with potential healthy value-added. *International Journal of Food Microbiology*, 284, 22–30. https://doi.org/10.1016/j.ijfoodmicro.2018.06.028

Cardello, A. V., Pineau, B., Paisley, A. G., Roigard, C. M., Chheang, S. L., Guo, L. F., Hedderley, D. I., & Jaeger, S. R. (2016). Cognitive and emotional differentiators for beer: An exploratory study focusing on "uniqueness". *Food Quality and Preference*, 54, 23–38. https://doi.org/10.1016/j.foodqual.2016.07.001

Carroll, G. R., & Swaminathan, A. (2000). Why the microbrewery movement? Organizational dynamics of resource partitioning in the U.S. brewing industry. *American Journal of Sociology*, 106, 715–762. https://doi.org/10.1086/318962

Costell, E. (2002). A comparison of sensory methods in quality control. *Food Quality and Preference*, 13, 341–353. https://doi.org/10.1016/S0950-3293(02)00020-4

Donadini, G., Fumi, M. D., & Newby-Clark, I. R. (2015). An investigation of matches of bottom fermented red beers with cheeses. *Food Research International*, 67, 376–389. https://doi.org/10.1016/j.foodres.2014.11.004

Escofier, B., & Pages, J. (1994). Multiple factor analysis (AFMULT package). *Computational Statistics & Data Analysis*, 18, 121–140. https://doi.org/10.1016/0167-9473(94)90135-X

Giménez, A., & Ares, G. (2019). Sensory shelf life estimation. In C. M. Galanakis (Ed.), *Food quality and shelf life* (pp. 333–357). Academic Press. https://doi.org/10.1016/B978-0-12-817190-5.00011-2

Giménez, A., Ares, F., & Ares, G. (2012). Sensory shelf-life estimation: A review of current methodological approaches. *Food Research International*, 49, 311–325. https://doi.org/10.1016/j.foodres.2012.07.008

Gómez-Corona, C., Escalona-Buendía, H. B., García, M., Chollet, S., & Valentin, D. (2016). Craft vs. industrial: Habits, attitudes and motivations towards beer consumption in Mexico. *Appetite*, 96, 358–367. https://doi.org/10.1016/j.appet.2015.10.002

Greimas, A. J., Courtés, J., Crist, L., & Patte, D. (1982). *Semiotics and language: An analytical dictionary* (Vol. 10). Indiana University Press.

Hein, K. A., Hamid, N., Jaeger, S. R., & Delahunty, C. M. (2012). Effects of evoked consumption contexts on hedonic ratings: A case study with two fruit beverages. *Food Quality and Preference*, 26, 35–44. https://doi.org/10.1016/j.foodqual.2012.02.014

Holtkamp, C., Shelton, T., Daly, G., Hiner, C. C., & Hagelman, R. R. (2016). Assessing Neolocalism in microbreweries. *Papers in Applied Geography*, 2, 66–78. https://doi.org/10.1080/23754931.2015.1114514

Hough, G. (2010). *Sensory shelf life estimation of food products*. CRC Press. https://doi.org/10.1201/9781420092943

Hough, G., & Garitta, L. (2012). Methodology for sensory shelf-life estimation: A review. *Journal of Sensory Studies*, 27, 137–147. https://doi.org/10.1111/j.1745-459X.2012.00383.x

Hough, G., Garitta, L., & Gómez, G. (2006). Sensory shelf-life predictions by survival analysis accelerated storage models. *Food Quality and Preference*, 17, 468–473. https://doi.org/10.1016/j.foodqual.2005.05.009

King, S. C., & Meiselman, H. L. (2010). Development of a method to measure consumer emotions associated with foods. *Food Quality and Preference*, 21, 168–177. https://doi.org/10.1016/j.foodqual.2009.02.005

Labuza, T. P., & Schmidl, M. K. (1988). Use of sensory data in the shelf life testing of foods: Principles and graphical methods for evaluation. *Cereal Foods World*, 33, 193–206.

Lahne, J. (2019). Food combinations and food and beverage combinations in meals. In H. L. Meiselman (Ed.), *Context: The effects of environment on product design and evaluation* (pp. 307–321). Woodhead Publishing. https://doi.org/10.1016/B978-0-12-814495-4.00015-5

Lee, J., & Chambers, D. H. (2010). Flavors of green tea change little during storage. *Journal of Sensory Studies*, 25, 512–520. https://doi.org/10.1111/j.1745-459X.2010.00283.x

Martínez, A., Vegara, S., Martí, N., Valero, M., & Saura, D. (2017). Physicochemical characterization of special persimmon fruit beers using bohemian pilsner malt as a base: Physicochemical characterization of special persimmon fruit beers. *Journal of the Institute of Brewing*, 123, 319–327. https://doi.org/10.1002/jib.434

Meiselman, H. L. (2013). The future in sensory/consumer research: Evolving to a better science. *Food Quality and Preference*, 27, 208–214. https://doi.org/10.1016/j.foodqual.2012.03.002

Mustonen, S., Hissa, I., Huotilainen, A., Miettinen, S. M., & Tuorila, H. (2007). Hedonic responses as predictors of food choice: Flexibility and self-prediction. *Appetite*, 49, 159–168. https://doi.org/10.1016/j.appet.2007.01.005

Næs, T., Brockhoff, P. B., & Tomic, O. (2011). *Statistics for sensory and consumer science*. John Wiley & Sons.

Paternoster, A., Jaskula-Goiris, B., Buyse, J., Perkisas, T., Springael, J., Braet, J., & De Cooman, L. (2020). The relationship between flavour instability, preference and drinkability of fresh and aged beer. *Journal of the Institute of Brewing*, 126, 59–66. https://doi.org/10.1002/jib.582

Peryman, D. R., & Pilgrim, F. J. (1957). Hedonic scale method of measuring food preferences. *Food Technology*, 11, 9–14.

Pierguidi, L., Spinelli, S., Dinnella, C., Prescott, J., & Monteleone, E. (2019). Individual differences in perceived complexity are associated with different affective responses to alcoholic cocktails. *Food Quality and Preference*, 76, 47–59. https://doi.org/10.1016/j.foodqual.2019.03.010

Pierguidi, L., Spinelli, S., Dinnella, C., Prescott, J., & Monteleone, E. (2020a). Liking patterns moderate the relationship between sensory, emotional and context appropriateness profiles: Evidences from a global profile study on alcoholic cocktails. *Food Quality and Preference*, 83, 103904. https://doi.org/10.1016/j.foodqual.2020.103904

Pierguidi, L., Spinelli, S., Dinnella, C., Prescott, J., & Monteleone, E. (2020b). Sensory acceptability and personality traits both determine which contexts are preferred for consumption of alcoholic cocktails. *Food Quality and Preference*, 85, 103978. https://doi.org/10.1016/j.foodqual.2020.103978

Rastier, F., & Riemer, N. (2015). Interpretative semantics. In N. Riemer (Ed.), *The routledge handbook of semantics* (pp. 491–506). Routledge.

Salanță, L. C., Coldea, T. E., Ignat, M. V., Pop, C. R., Tofană, M., Mudura, E., Borşa, A., Pasqualone, A., & Zhao, H. (2020). Non-alcoholic and craft beer production and challenges. *Processes*, 8, Article 11. https://doi.org/10.3390/pr8111382

Spinelli, S., Dinnella, C., Ares, G., Abbà, S., Zoboli, G. P., & Monteleone, E. (2019). Global profile: Going beyond liking to better understand product experience. *Food Research International*, 121, 205–216. https://doi.org/10.1016/j.foodres.2019.03.013

Spinelli, S., Dinnella, C., Masi, C., Zoboli, G. P., Prescott, J., & Monteleone, E. (2017). Investigating preferred coffee consumption contexts using open-ended questions. *Food Quality and Preference*, 61, 63–73. https://doi.org/10.1016/j.foodqual.2017.05.003

Spinelli, S., Masi, C., Dinnella, C., Zoboli, G. P., & Monteleone, E. (2014). How does it make you feel? A new approach to measuring emotions in food product experience. *Food Quality and Preference*, 37, 109–122. https://doi.org/10.1016/j.foodqual.2013.11.009

Spinelli, S., & Monteleone, E. (2018). Emotional responses to products. In G. Ares & P. Varela (Eds.), *Methods in consumer research* (Vol. 1, pp. 261–296). Woodhead Publishing. https://doi.org/10.1016/B978-0-08-102089-0.00011-X

Stewart, G. G. (2016). Beer shelf life and stability. In P. Subramaniam & P. Wareing (Eds.), *The stability and shelf life of food* (pp. 293–309). Elsevier. https://doi.org/10.1016/B978-0-08-100435-7.00010-1

Thomson, D. (2010). Going beyond liking: measuring emotional and conceptual profiles to make better new products. In S. R. Jaeger & H. J. H. MacFie (Eds.),*Consumer-driven innovation in food and personal care products* (pp. 219–274). Elsevier. https://doi.org/10.1533/9781845699970.2.219

Valentoni, A., Santoru, A., Sanna, M., Fanari, M., Porcu, M. C., Fadda, A., … & Pretti, L. (2022). Evolution of sensory analysis attributes and volatile aging markers in bottle fermented craft beers during storage at different temperatures. *Food Chemistry Advances*, 1, 100151.

Violi, P. (2001). *Meaning and experience*; (Translated) Jeremy Garden. Indiana University Press.

Widmark, E. M. P. (1981). In R. C. Baselt (Ed.), *Principles and applications of medico-legal alcohol determination [1932]*. Biomedical Publications.

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