Immersive Multisensory Setting and Taste - Mouthfeel Association

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1. BACKGROUND

In recent years, the intersection of sensory perception and environmental design has emerged as a fascinating area of investigation, offering insights into how our surroundings influence sensory experiences. The concept of multisensory environments, where auditory, visual, and lighting characteristics are meticulously composed, has been shown to significantly impact the taste perception of food and beverages [1-3]. Despite the growing interest, there remains a limited number of studies exploring the intricate relationship between flavour, mouthfeel, and immersion design in multimodal environments. **Our current study aims to investigate the taste and mouthfeel association with multisensory scenes.** This study highlights the importance of understanding the interaction of our sensory modalities and its potential for creating environments that enhance sensory experiences.

2. METHODS

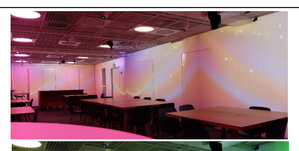
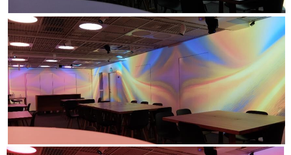
Fifty-five participants (38 females and 17 males, age 18-60 years old) were exposed to five different multisensory scenes each designed to be compatible with specific **three taste attributes: sweet (SW), sour (SO), bitter (BIT),** and **two thickness attributes (TH1 and TH2)**.

The experiment followed 1x5 between participant design.

- Visual animation stimuli were designed with **Adobe After Effect and genmo.ai** using visual prompts which congruent to specific taste, according to review studies (e.g. sweet congruent with round, regular, symmetry, etc) and lighting colour referencing to the colour in designed video animation.
- Meanwhile audio music stimuli were composed **using digital piano and Logic software,** by modifying three sonic attributes: articulation (legato and staccato), tempo (60 bpm and 120 bpm), and pitch (high and low) [4].

Audio and Visual Stimuli

Table 1: Audio and Visual stimuli design, visual prompts, and music attributes

	Video	QR code	Visual-taste prompts	Music
SW			Regular, symmetrical, orderly, round, fluid, relaxing, warm light, red-pink	Legato, Slow tempo (70 bpm), and high pitch
SO			Irregular, asymmetrical, chaotic, angular, solid, fast, stimulating, cold lighting, green	Staccato. Fast tempo (120 bpm), and high pitch
BIT			Irregular, asymmetrical, chaotic, angular, fast, cold lighting, grey	Legato, Fast tempo (120 bpm), and low pitch
TH1			Slow, stimulating, red, warm lighting/ambience, heavy	Staccato, Slow tempo (70 bpm), and low pitch
TH2			Slow, stimulating, red, warm lighting/ambience, heavy	Legato, Slow tempo (70 bpm), and low pitch.

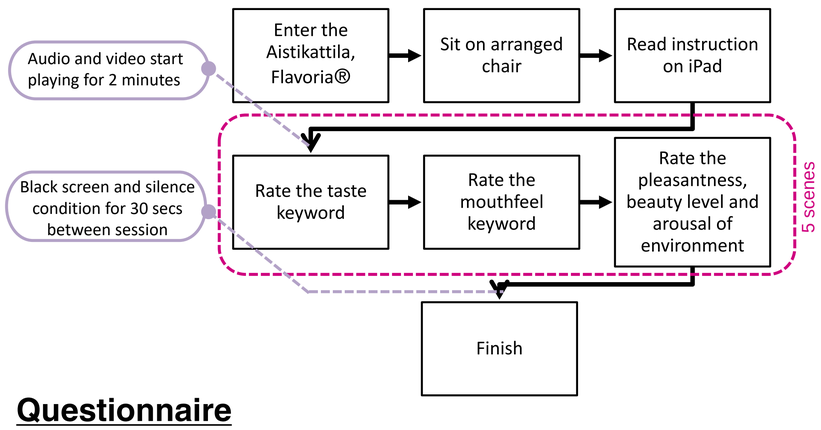
Study Facility and Environment

The study was conducted in the **Aistikattila, Flavoria® research restaurant in Turku, Finland**. The room was a 94 m2 rectangular room, and the temperature inside was held consistently at 21 ◦C on all study days. Eight speakers placed around the audience, 7.1 surround sound creates an immersive listening experience were installed in the ceiling, alongside 60 adjustable lights. During all study days, all videos were played back using **QLab 5 software** and were projected using four **Epson EB-PU1006W** projector onto the two sides of wall.

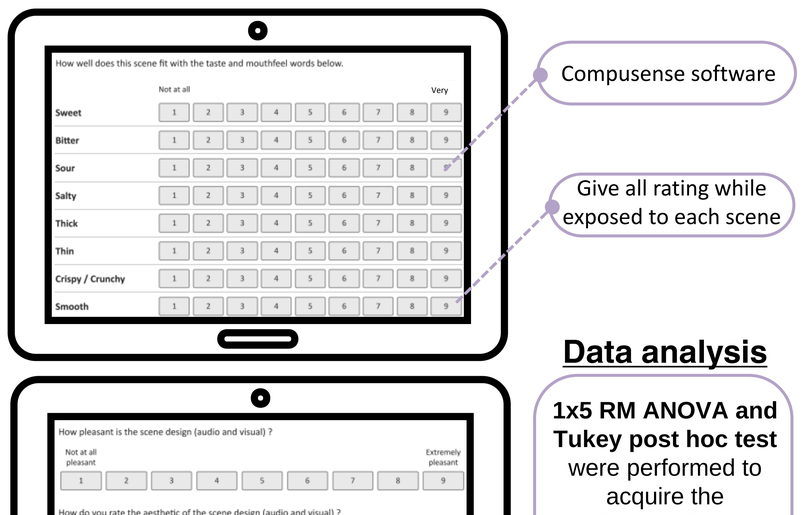
- In the no-sound condition, the average sound pressure level (LAeq = Equivalent Continuous Sound Level) of the empty room was **40 dBA**,
- Average SPL for all music sound conditions set to **49.5 dBA**. At this level, the soundtracks were clearly audible and maintained high fidelity, while not being overstated.
- Sound pressure levels in the study facility were measured in the centre of the room on all days before participants' arrival to ensure sound playback volume was consistent for all conditions. Measurements were obtained using **Minidsp UMIK-1 and REW software.**

Experiment Procedure

Figure 1: Experiment flow and Questionnaire



Questionnaire



Data analysis

1x5 RM ANOVA and Tukey post hoc test were performed to acquire the significance difference of rating between the means of 5 groups (SW, SO, BIT, TH1, TH2) per each **taste and mouthfeel keywords**

3. RESULTS AND DISCUSSION

1x5 RM ANOVA results indicated that regarding the **taste keyword:**

- the "**sweet"** was significantly associated with the scene SW compared to other scenes, $F(4,216)=31.0$, $p<0.001$, $\eta^2_p=0.365$.
- In contrast, the "**sour"** was most associated with SO, $F(4,216)=10.6$, $p<0.001$, $\eta^2_p=0.164$.
- Remarkably, the "**bitter"** was rated significantly high within the SO scene, $F(4,216)=11.2$, $p<0.001$, $\eta^2_p=0.171$,
- **"Salt"** significantly most rated within the BIT, $F(4,216)=12.6$, $p<0.001$, $\eta^2_p=0.190$.

In terms of the **mouthfeel keyword**:

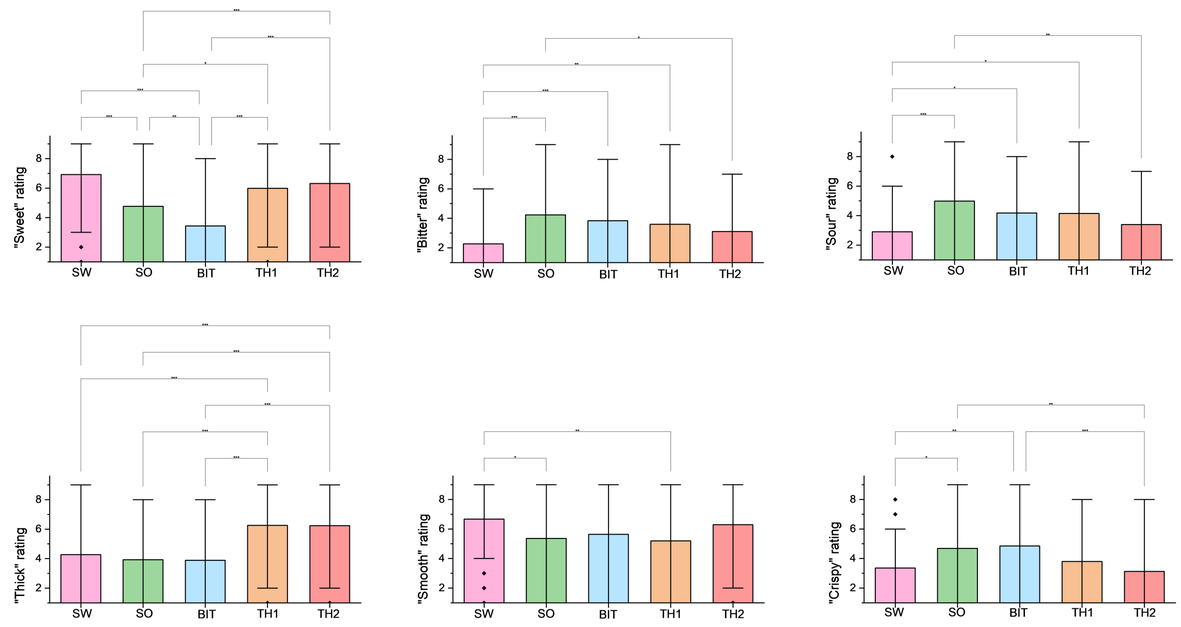
- The "**thick"** was assessed highest while inside the scene TH1, $F(4,216)=19.4$, $p<0.001$, $\eta^2_p=0.265$.
- Interestingly, the "**smooth"** rating is significantly most well associated the SW scenes, $F(4,216)=5.46$, $p<0.001$, $\eta^2_p=0.092$, and TH2 as second most.
- The "**thin"** is significantly most connected the BIT, $F(4, 216)=5.46$, $p<0.001$, $\eta2_p=0.092$,
- **"Crispy"** significantly most rated within the BIT, $F(4, 216)=14.4$, $p<0.001$, $\eta^2_p=0.211$

Valence rating shows significant effect with BIT was rated as least pleasant compared to others, $F(4, 216)=14.4$, $p<0.001$, $\eta^2_p=0.211$.

With the similar trends, the **beauty level** shows significant effect with BIT was rated as least beauty compared to others, $F(4, 216)=9.69$, $p<0.001$, $\eta^2_p=0.152$.

On the other hand, SO and BIT rated significantly as the most **stimulating** scene in compared to other designed scenes, $F(4, 216)=20.0$, $p<0.001$, $\eta^2_p=0.270$.

Figure 2: Means rating and Tukey post hoc test per taste (sweet, bitter, sour) and mouthfeel word (thick, smooth, crispy) within five designed multisensory scenes.



* p<=0.05 ** p<=0.01 *** p<=0.001

4. CONCLUSIONS

Overall, the findings highlight the potential of multisensory design to modulate taste and mouthfeel perceptions, paving the way for more immersive and enjoyable dining experiences. This study underscores **the importance of considering sensory elements in environmental design, not only for their aesthetic value but also for their ability to enhance the sensory attributes** of food and beverages. By meticulously designing visual, audio, and lighting conditions, it is possible to design environments that significantly influence how individuals perceive taste and mouthfeel, offering new avenues for sensory optimization in gastronomy.

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