Restaurant Design with VR Behavior Testing

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Restaurant Design using VR Behavior Testing

Problem:
The built environment shapes our emotions and behavior.

Given this, can we design restaurants to foster healthy eating behaviors?

Goals:
To test how design affects emotions and behavior.

To test if VR usability for eating behavior testing.

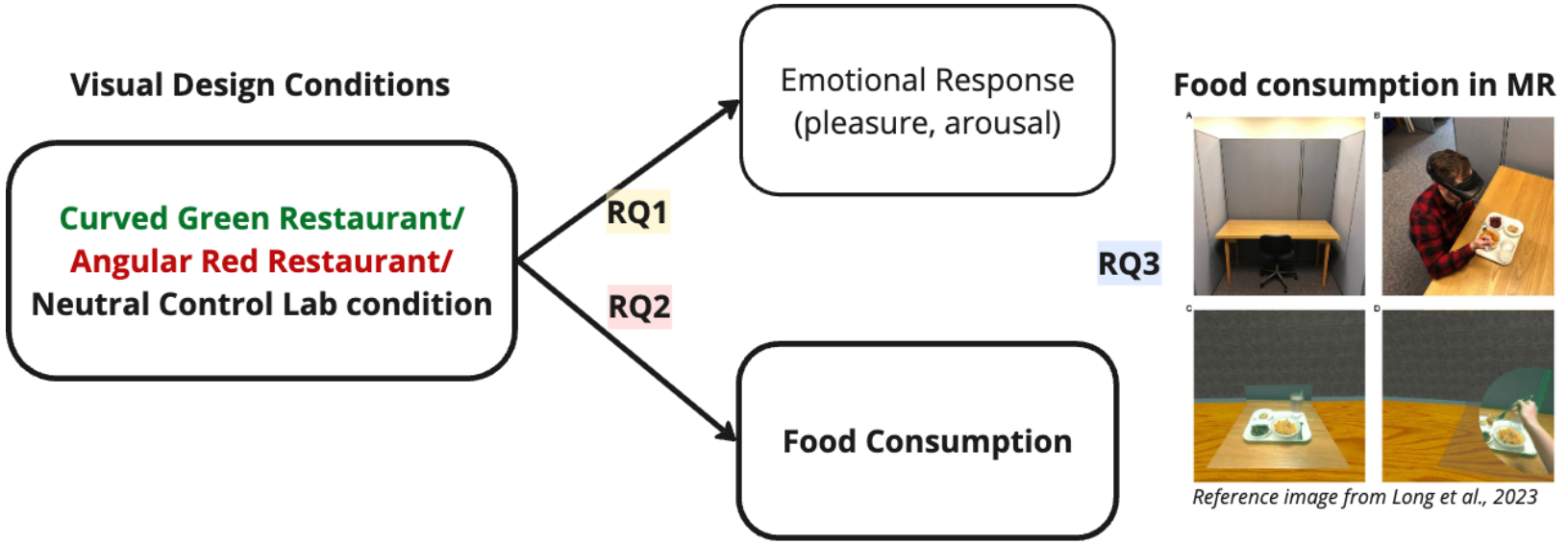
Image generated with GPT-5.1

Research Questions

RQ1 — Design Impact on Emotion: How does restaurant visual design affect emotional responses?

RQ2 — Design → Eating Behavior: Does restaurant design affect eating behavior (food consumption)?

RQ3 — VR Usability: Is mixed-reality VR a valid and usable method for studying eating behavior?



Method

Within-subjects VR experiment.

- 3 conditions – green curved, red angular, neutral lab (control).

VR Pilot lab study (n = 20).

- Convenience sampling.
- 3 visits each = 60 visits.
- SPSS analysis – t-test, Anova, Linear mixed models

Before the VR study:

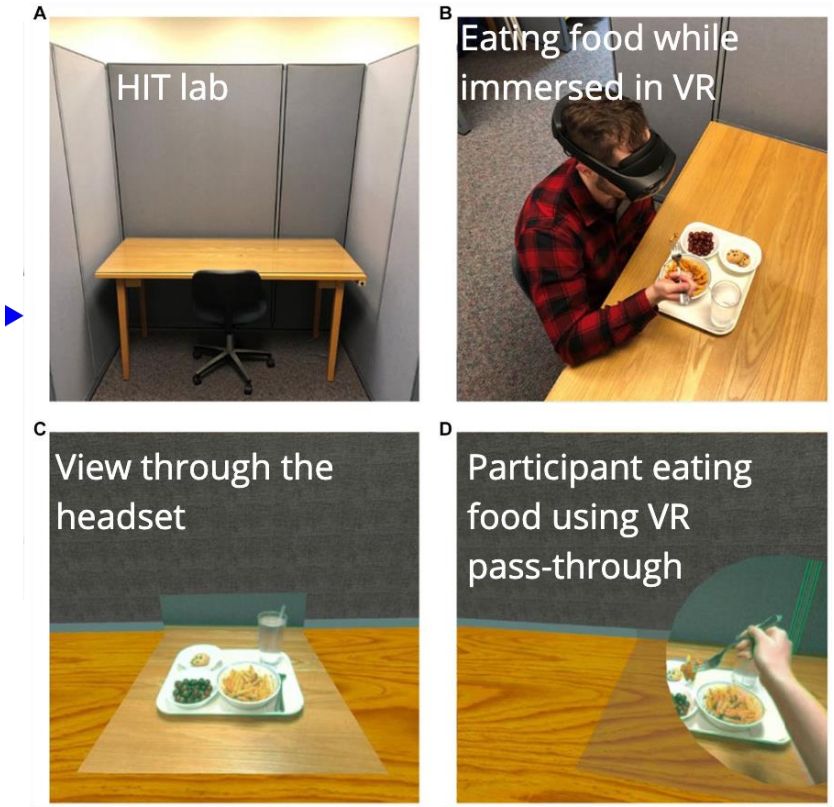
Online pre-test (n=83) → VR visual stimuli validation

Pilot VR Experiment

All three virtual restaurant environments were built in Unity and optimized for Meta Quest Pro. **The spaces were designed for seated, first-person dining to align with participants' real-world posture in the lab (see below).**

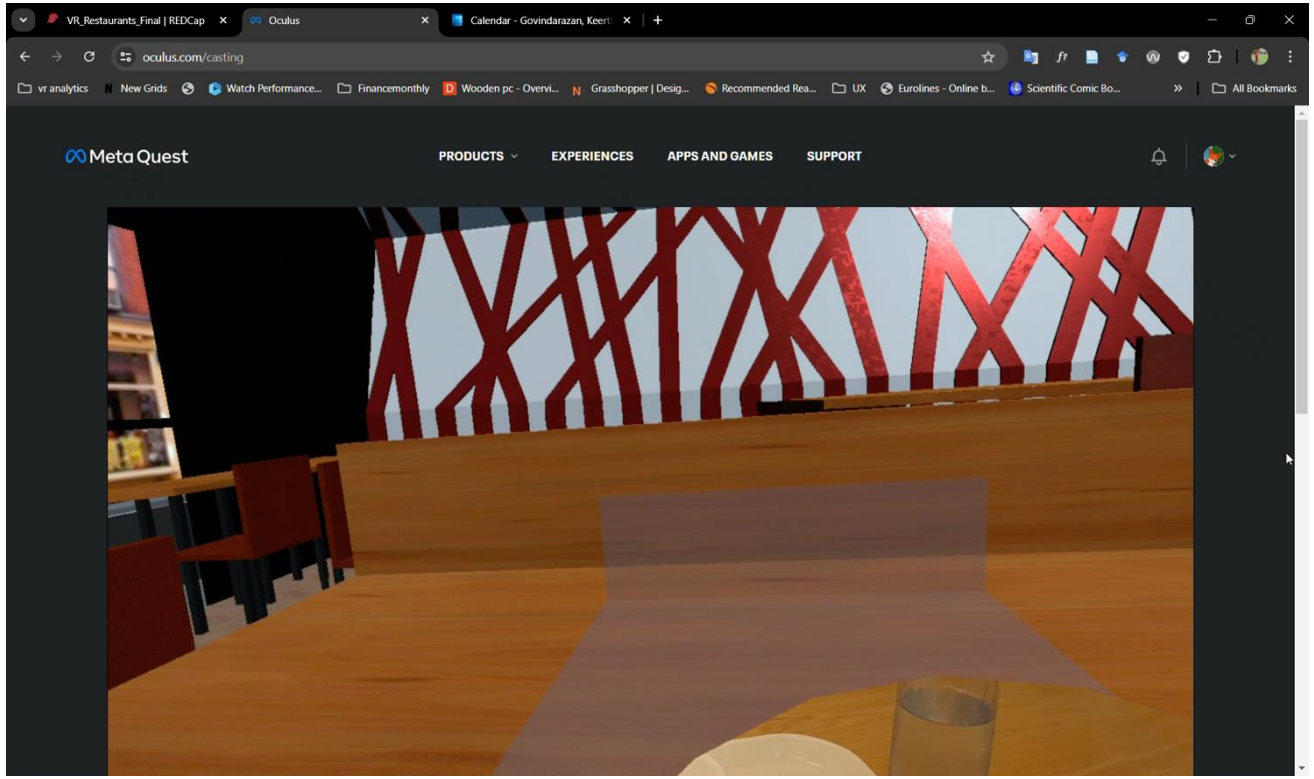
Data Collection Setup

Food consumption in MR



Reference image from Long et al., 2023

Participant POV - Red Angular Environment



Key Takeaways (Results from linear mixed models using SPSS)

RQ1 — Design Impact on Emotion: NEGATIVE EMOTIONS ARE SHAPED BY SPATIAL DESIGN.

Angular red restaurant increased users' negative effect.

Familiarity, not design, predicted positive affect.

RQ2 — Design → Eating Behavior: NO IMPACT

No significant environmental effect on intake

Slight trend: Angular Red > Curved Green > Control

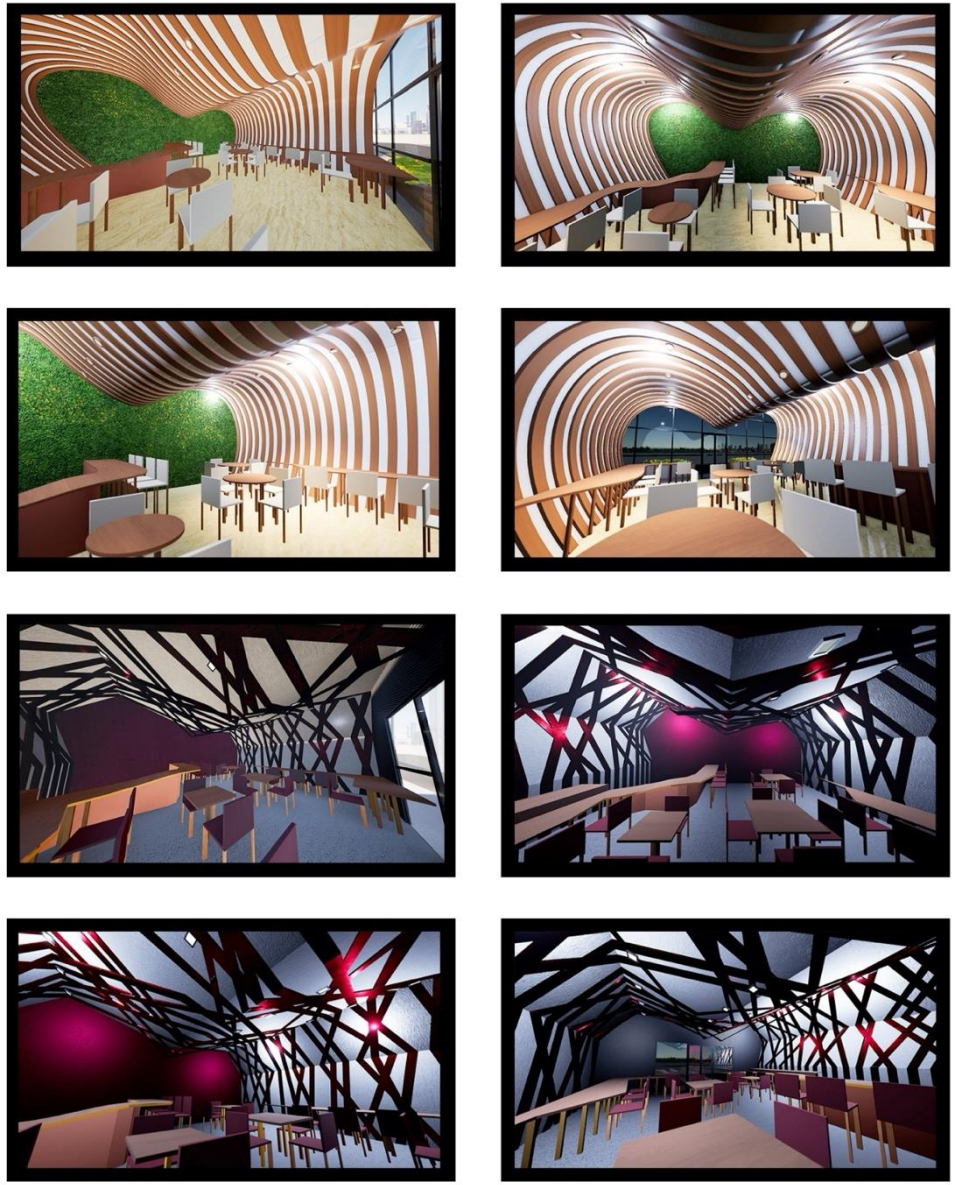
RQ3 — VR Usability: FOOD CONSUMPTION DEPENDS ON VR USABILITY – NEEDS IMPROVEMENT

High Realism ratings reflected - VR restaurant felt believable, and realistic – Supports tool Usability

Natural Interaction scores (a usability measure) predicted food intake. High variability in this score.

⇒ Technical friction (hand-tracking, lag, headset comfort) disrupted the eating experience – Needs refinement.

Additional Information



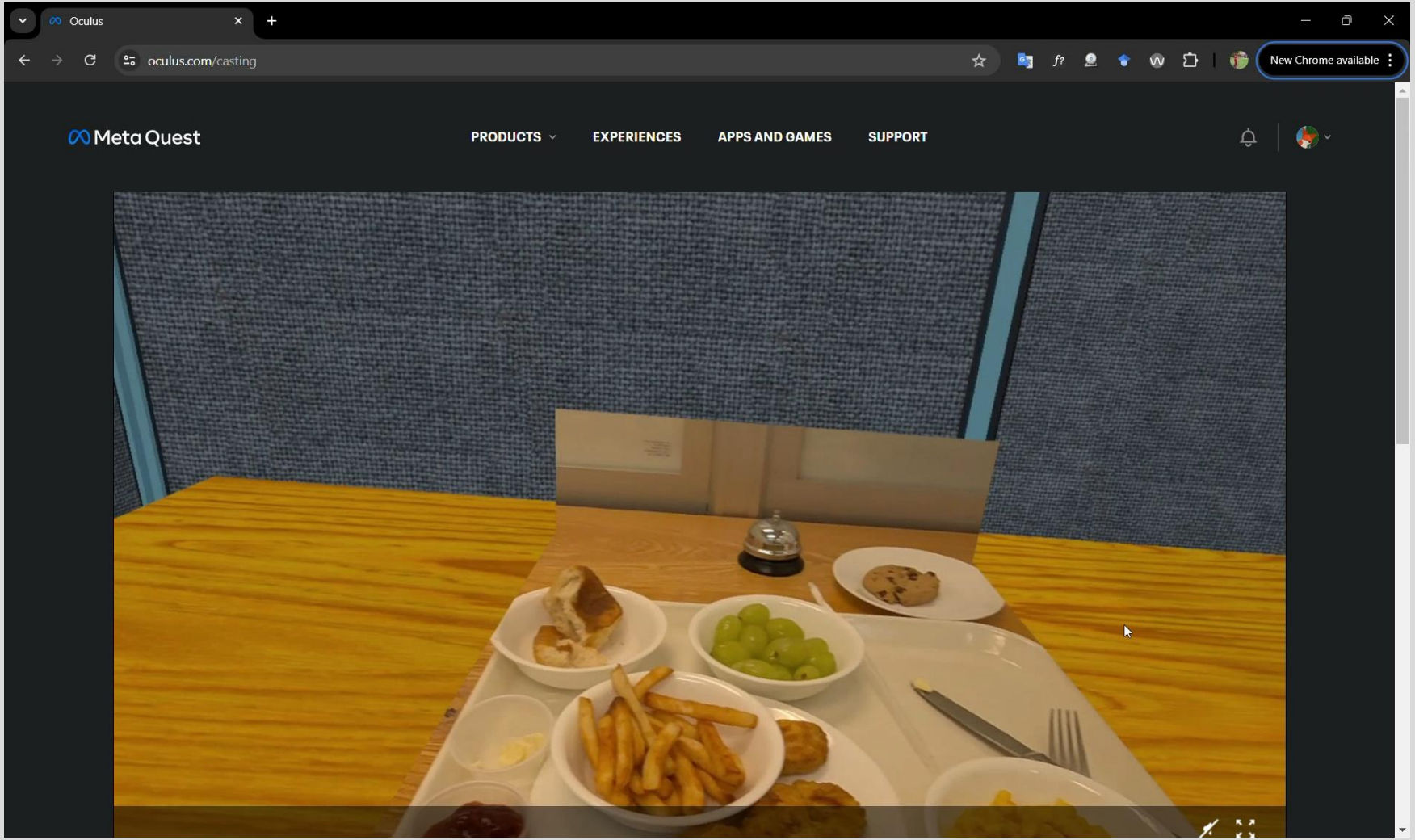
Pre-test

Online study (n=83); Cloud Research Connect

Roof form, colour, and spatial quality differed significantly across Green and Red environments.

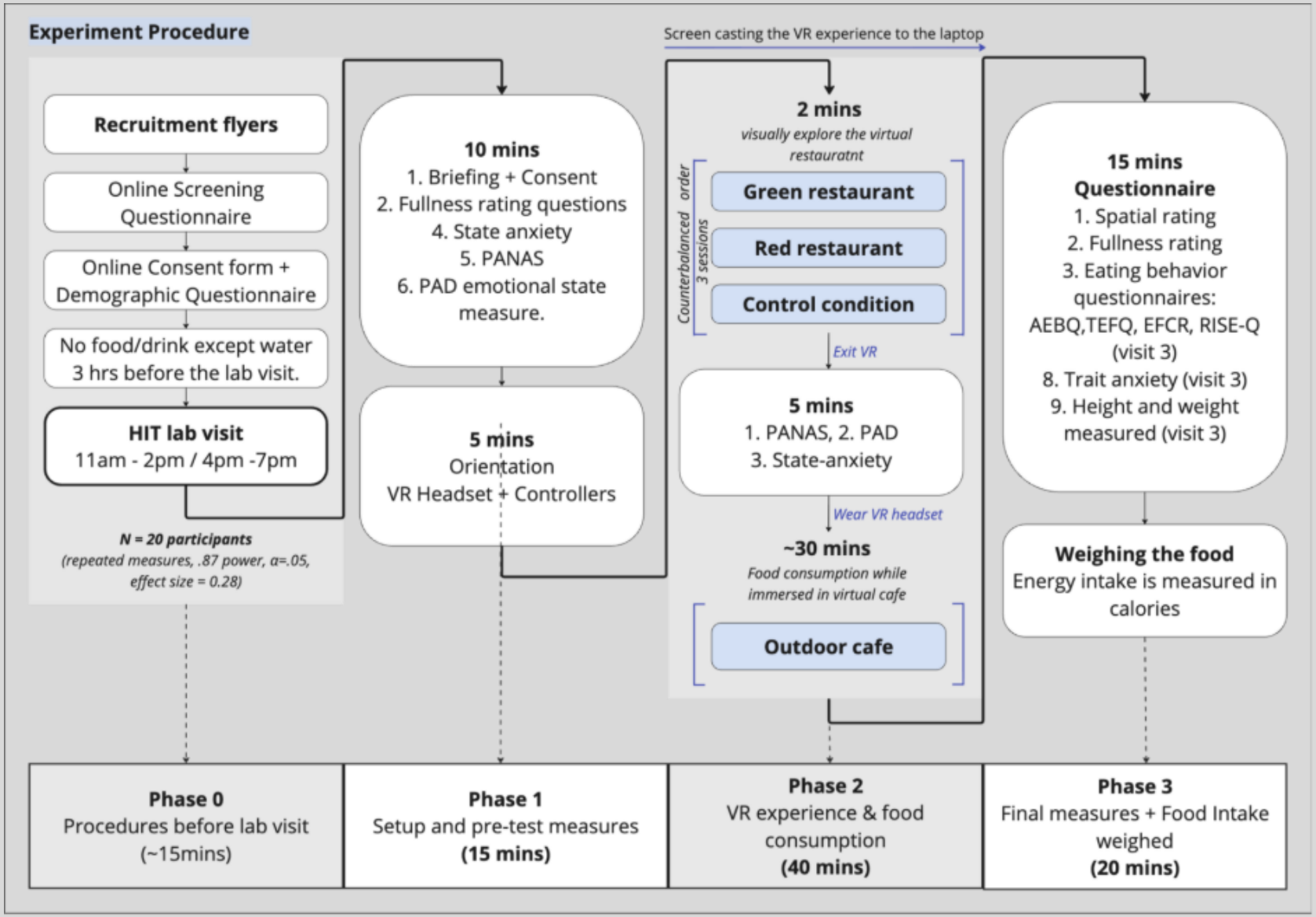
Measure	Curved Green (M)	Angular Red (M)	Statistic
Roof form (Curved vs. Angular)	8.35	2.54	$t(82) = 20.37$, $p < .001$
Spacious vs. Narrow	6.02	4.49	$t(82) = 5.11$, $p < .001$
Familiar vs. Unfamiliar	5.02	3.92	$t(82) = 3.32$, $p = .001$
Simple vs. Complex	4.75	3.54	$t(82) = 3.82$, $p < .001$
Ordered vs. Chaotic	5.86	4.29	$t(82) = 4.46$, $p < .001$
Harmonious vs. Not Harmonious	6.19	4.46	$t(82) = 5.16$, $p < .001$
Symmetrical vs. Asymmetrical	5.04	3.75	$t(82) = 4.11$, $p < .001$

VR LAB STUDY: Participant POV – Neutral Lab Environment



VR LAB STUDY: Participant POV - Green Curved Environment

Additional Information



VR LAB STUDY Procedure

<u>Sample Measures:</u> Emotional and Affective States

Positive and Negative Affect Schedule (PANAS)

20 emotion adjectives (10 positive, 10 negative) rated on a 5-point scale (1–5).

Example items: interested, excited (positive); distressed, upset (negative).

Scores averaged to form Positive Affect and Negative Affect subscales.

Pleasure–Arousal–Dominance (PAD; Mehrabian & Russell, 1974):

18 bipolar adjective pairs on 9-point scales (–4 to +4).

Example pairs: unhappy–happy (pleasure), excited–calm (arousal), controlled–in-control (dominance).

Six items per dimension averaged to yield Pleasure, Arousal, and Dominance scores.

Additional Information

Presented at

ANFA 2025

Academy of Neuroscience For Architecture

PennState

Can Visual Design of Interior Spaces Influence Eating Behavior? A Mixed Reality Pilot Experiment of a Restaurant Environment

ANFA

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Overview

Built environments influence both emotion and behavior. This study examined whether the visual design of restaurant interiors (green/curvilinear vs. red/angular vs. neutral control) shapes eating behavior in a mixed-reality setting.

Hypotheses (based on The environmental psychology model (Mehrabian & Russell, 1974):

H1 — Visual design → emotional response
H2 — Visual design → food intake
H3 — Emotion mediates
RQ1 — Usability of VR/MR evaluation

Method:

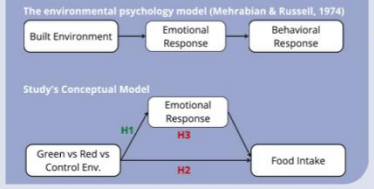
3 Conditions: Within-subjects design (N = 20; 57 valid sessions).
→ Mixed reality VR setup was used where participants can see the real food placed on the table while immersed in VR. The VR environment has a window into the real world to help participants see the food and their hands while eating wearing the headset.
→ Participants consumed standardized meals while immersed in three VR restaurant conditions
→ Emotional responses were measured using the PAD model (pleasure, arousal) and PANAS affect scales, pre- and post-meal.
→ Food intake was calculated by plate-waste weighing.

Key results:

•**H1** : The **red/angular environment significantly increased negative affect** compared to the control condition (p = .012).
•**H2:** No significant effect of environment on food intake (p = .727). Instead, emotional overeating tendencies predicted higher intake across all environments.
•**H2:** Mediation analysis showed that emotion did not explain the environment–intake relationship.
•**RQ1:** VR usability mattered: participants reporting more natural interaction consumed more food (p = .038).

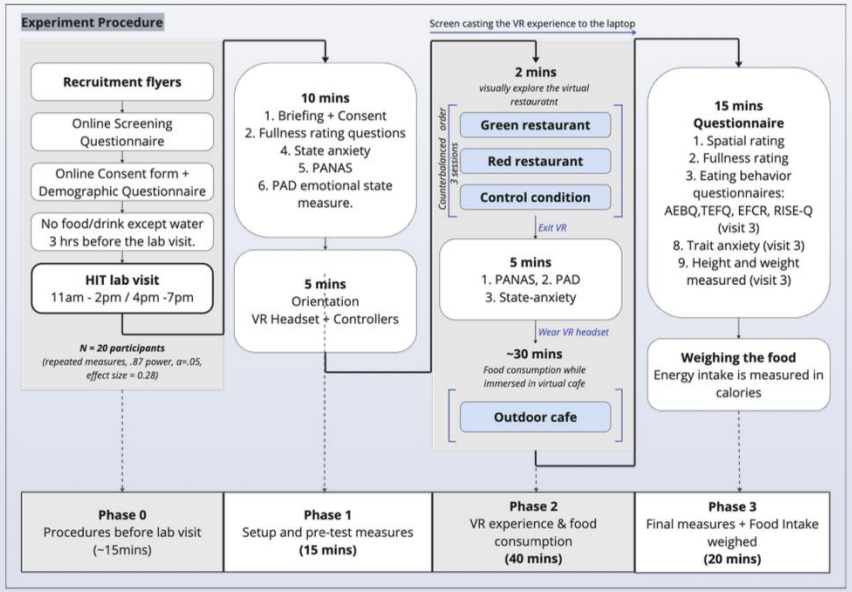
Conclusion:

Visual design shaped emotions but not food intake. Ensuring natural, intuitive VR interaction is crucial for using mixed-reality as a valid tool for behavioral research.

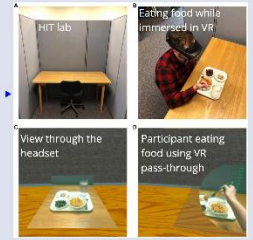


ANFA 2025 ANFA

Method



Stimuli



Reference image from Long et al., 2023

Design features:

•*Green*: Curved roof, spacious/open, familiar, simple, ordered, harmonious, symmetrical.
•*Red*: Angular roof, narrow/closed, unfamiliar, complex, chaotic, not harmonious, asymmetrical.
•*Control*: Neutral lab-like room with minimal cues.

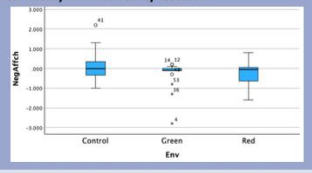
Green Restaurant

Red Restaurant

Results & Conclusion

Emotional responses (H1):
•Environment significantly influenced negative affect, $F(2,44.48) = 3.91$, $p = .027$.
•**Red environment → greater increase in negative affect** vs. Control ($B = 0.52$, $p = .012$).
•Positive affect, pleasure, and arousal showed no environment effects.
•Familiarity predicted higher positive affect ($p = .017$).
Food intake (H2):
•No significant effect of environment on grams consumed, $F(2,46.02) = 0.32$, $p = .727$.
•Emotional overeating trait predicted higher intake ($B = 68.75$, $p = .028$).
Mediation (H3):
•Negative affect change did not mediate the environment → food intake relationship (Sobel $Z = 0.64$, $p = .52$).
Usability (RQ1):
•Natural Interaction ratings predicted higher intake ($B = 1.30$, $p = .038$).
•Realism and Natural Eating ratings did not predict intake.

This pilot study shows that restaurant design shaped emotional responses more than eating behavior. The red environment significantly increased negative affect compared to control, underscoring the sensitivity of negative emotions to visual cues like color and form. Positive affect, pleasure, and arousal were unaffected, but familiarity predicted higher positive affect, suggesting recognition can buffer emotional experience. Food intake did not differ across environments, indicating visual cues alone may be insufficient without multisensory input. Instead, individual traits such as emotional overeating predicted intake. Usability also mattered: participants reporting more natural interaction consumed more, highlighting the importance of technical fidelity in mixed-reality research.



Online pre-test of stimuli to ensure visual manipulation:

Measure	Green (M / %)	Red (M / %)	Stat
Roof form (Curved vs. Angular)	8.35	2.54	$t(82)=-20.37$, $p<.001$
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The End.

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