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Effects of personality traits and context congruency on participant engagement in traditional central location tests and congruent versus incongruent digital immersive environments during affective product testing

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ABSTRACT

Digital immersive environments (DIEs) are increasingly employed in sensory studies to create more ecologically valid settings for product testing. However, individual differences appear to influence participant level of engagement within product-(in)congruent DIEs. This investigation studied how environmental congruency and personality traits affect consumer engagement in DIEs compared to a traditional controlled environment. Data from two studies conducted in the Feast Lab (New Zealand) were analysed. Both studies included three contexts: congruent, incongruent (both DIEs), and a traditional central location test. Engagement scores were assessed alongside Big Five personality traits, technophilia levels, and Life Orientation Test-Revised (LOT-R) scores. Findings revealed that engagement levels were consistently higher in DIEs than in the traditional controlled environment across both studies. Interestingly, participants reported lower distraction in DIEs compared to the controlled context in both the studies. In study 1, personality traits such as agreeableness and neuroticism significantly influenced engagement dimensions. Participants with higher scores in agreeableness and neuroticism demonstrated greater involvement and sensory awareness. Additionally, those with high conscientiousness scores exhibited heightened sensory awareness specifically in congruent environments in both studies. In Study 2, participants with higher conscientiousness scores also reported greater environmental aesthetics, involvement, and perceived realism. Technophilia showed a negative association with immersion and perceived realism in Study 1, but no such effect was observed in Study 2. These findings highlight the importance of considering individual personality traits when designing and interpreting sensory studies using immersive technologies, to ensure more accurate and inclusive consumer insights.

1. Introduction

Consumer testing plays a crucial role in ensuring product success in competitive markets. Traditionally, most consumer studies are conducted in controlled environments such as sensory booths or other central locations. However, such settings do not accurately reflect the real-life conditions in which consumers typically consume the product (Giezenaar & Hort, 2021; Torrico et al., 2023), which may lead to product failure. However, with recent technological advancements, it is now possible to conduct product testing in digitally immersive environments (DIEs) that closely simulate real-life experiences while allowing scientific control over other variables. As a result, the number of studies conducted in immersive digital settings is growing significantly (Bhavadharini et al., 2023; Korsgaard et al., 2020; Long et al.,

Abbreviations: A-NZ, Aotearoa New Zealand; CLT, Central location test; LOT-r, Life Orientation Test Revised; PB, plant-based.

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2025; Low et al., 2021; Mishra et al., 2021; Schouteten et al., 2024; Woodall & Hollis, 2024; Zholzhanova et al., 2025; Zulkarnain & Gere, 2025).

Digital immersive technologies have proven highly effective in areas such as food evaluation, product development, and packaging design (Branca et al., 2023; D'Arco & Marino, 2025; Dong et al., 2021). Studies have shown that consumers tend to behave similarly in DIEs and real-life scenarios (Branca et al., 2023; Dong et al., 2021; Hathaway & Simons, 2017; Low et al., 2021; Torrico et al., 2020). In addition to ecological validity, DIEs provide a more engaging environment, which contributes to better product discrimination (Andersen et al., 2019; Bangcuyo et al., 2015; Hannum et al., 2020; Hathaway & Simons, 2017; Sinesio et al., 2019; Zandstra et al., 2020). Bangcuyo et al. (2015) found that using immersive technologies like virtual coffee shop environments with sensory cues led to more reliable and discriminating hedonic responses in coffee tasting than traditional sensory booths. A study comparing cookie evaluations in standard control booth and a home-like immersive environments found that participants experienced greater immersion and exhibited more discriminating behaviour in the fully immersive home setting than in control and mixed immersive booth settings (Hathaway & Simons, 2017). Immersive setups enhance ecological validity and help predict consumer preferences more effectively, but congruency between the product and the environment is believed to play a critical role in shaping consumer responses (Giacalone, 2019; Giacalone & Jaeger, 2019).

A context/product congruency effect refers to the influence of alignment between a product and the environment in which the product is evaluated. Despite its relevance to consumer behaviour and sensory research, limited empirical studies have explored how contextual congruency/incongruency impacts engagement and product evaluation. A study investigating context/product congruency was conducted with 50 participants who evaluated cold brewed coffee under four different conditions: a congruent environment, and visually, auditory, and olfactory incongruent environments (Liu et al., 2019). The findings revealed that participants recalled contextual information more effectively and spent more time evaluating the coffee in the congruent condition compared to the incongruent ones. In contrast, incongruent sensory cues have led to lower levels of engagement and diminished attention during product evaluation (Liu et al., 2019). Engagement itself is a multifaceted construct, influenced by factors such as environmental aesthetics, involvement, immersion, sensory awareness, novelty and usability (Bangcuyo et al., 2015). These elements collectively influence the degree to which users sustain attention during product interaction. However, the specific ways in which product-(in)congruency context affects engagement and sense of presence remain unexplored. Understanding this relationship is essential for designing environments that enhance consumer experiences and support more meaningful product evaluations.

Consumer studies are now starting to employ digital immersive technologies assuming that all individuals respond to digital immersive experience in the same way. However, there is growing evidence to challenge this, suggesting that sensitivity to digital immersion may vary significantly across individuals (Bangcuyo et al., 2015; Lichters et al., 2021; Nijman et al., 2019). Studies have shown that participants experience different engagement, even when exposed to the same immersive environment (Krijn et al., 2004; Pan & Hamilton, 2018), and it may be assumed that these variations are caused by individual differences. Nijman et al. (2019) showed that some participants were more context-sensitive when evaluating beer in different contexts. These context-sensitive participants exhibited more discriminating responses in a bar setting compared to a lab environment, whilst context-insensitive participants showed consistent beer preferences across contexts. The context-sensitive group was identified through clustering based on product liking, and no personality traits were assessed in the study. However, several studies in psychology and behavioural sciences have reported that difference in presence, immersive tendencies and engagement in virtual environments are linked to personality traits (Kober & Neuper, 2013; Laarni et al., 2004; Murray et al., 2007).

Personality traits are relatively internal characteristics reflected in a person's responses, behaviour and attitudes (Goldberg, 1993; Roberts, 2009). The widely adopted Big Five personality model categorises these traits into five core domains: openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism (John, 1991), whilst additional constructs like Technophilia (Martínez-Córcoles et al., 2017) and the Revised Life Orientation Test (LOT-r) (Scheier et al., 1994) also influence human behaviour and cognition. Previous research has demonstrated that consumer personality traits significantly influence individual responses within immersive environments, particularly in the context of social media use (Azucar et al., 2018; Choi & Shin, 2017; Witmer & Singer, 1998; Xiao & Mou, 2019; Yu et al., 2020). In a large-scale online study involving 9633 university students in Taiwan, Yu et al. (2020) found that openness to experience and neuroticism were strongly associated with heightened immersion in social media platforms among young adults. These findings were supported by a previous online survey (N = 220) (Weibel et al., 2010), which revealed that openness, neuroticism, and extraversion were positively correlated with immersive experiences during media exposure. Laarni et al. (2004) reported that neuroticism showed no significant relationship with either the sense of presence or the level of immersion in virtual environments. Conversely, extraversion was found to be positively correlated with presence ratings, suggesting that individuals with higher levels of extraversion may experience a stronger sense of presence in immersive settings (Laarni et al., 2004). The influence of personality traits extends beyond social media. Similar patterns have been observed in immersive simulation games, as well as in educational and training contexts (Abedini, 2020; Bean & Groth-Marnat, 2016; Fariba, 2013; Xiao & Mou, 2019). Rosenthal et al. (2013) studied 95 participants (medical students and surgical residents) in Switzerland and found that resident surgeons who were less neurotic and exhibited higher levels of extraversion and conscientiousness performed better in virtual reality (VR) environments.

While the Big Five personality traits provide a broad understanding of individual differences, additional psychological constructs such as technophilia and optimism are particularly relevant in immersive environments. Both optimism and technophilia have been shown to influence consumer behaviour and enhance the sense of immersion in DIEs (Nurttila et al., 2015; Robillard et al., 2003). Optimism is the tendency to expect positive outcomes and view challenges as manageable. One of the most widely used tools to measure optimism is the Revised Life Orientation Test (LOT-r) (Scheier & Carver, 1985). A study of 785 Finnish undergraduates identified three study profiles—optimistic, bored, and pessimistic—based on achievement strategies and perceived competence. Optimistic students showed highest engagement and confidence, whilst pessimistic students were the most disengaged; bored students mainly lacked interest rather than ability (Nurttila et al., 2015). Technophilia is characterised by a positive disposition towards technology, often associated with greater openness to experience and an enhanced ability to learn and adapt to technology-based tools (Piccoli et al., 2001; Zhang & Goel, 2011).

Despite growing evidence that personality traits influence engagement in immersive environments, no prior research has examined how these traits affect consumer engagement with food stimuli presented in product-congruent and incongruent digital immersive environments. The two studies reported here enabled that gap to be investigated. The present research aimed to understand i) the impact of product context (in)congruency on overall engagement levels and specific engagement dimensions (usability, sensory awareness, environmental aesthetics, novelty, immersion, involvement, realism and distraction; and ii) how personality traits influence consumer engagement in both congruent and incongruent immersive settings in a food evaluation scenario. Understanding these dynamics affords valuable insights into understanding and tailoring sensory experiences based on individual psychological profiles.

2. Material and methods

To address the aims, data from two ongoing but complementary studies were utilised to examine how personality traits and product-context (in)congruency influence consumer engagement in immersive environments. Both studies followed the same overall experimental structure, enabling direct comparison across conditions. Therefore, the data for this investigation was procured from a Plant-based meatball study (PB meatball (Study 1) (Orr, 2024) and an ice cream study (Study 2) (Poggesi et al., under review) conducted at the Feast lab, Massey University, New Zealand. The PB meatball study was evaluated as low risk by Massey University Ohu Matatika 1 process (Application ID 4000027702), whilst the ice cream study received full ethics approval (Application ID OM1 23/48). Both studies were conducted with several other objectives, but both considered the impact of congruency on consumer response in DIE and a CLT.

2.1. Participants

For both studies, participants were recruited using the Food Experience and Sensory Testing (Feast) consumer database in A-NZ. The following inclusion criteria were assessed through a screening survey: i) aged between 18 and 55 years (PB meatball study) or 18 and 70 years (ice cream study), ii) able to communicate effectively in English, iii) not allergic or intolerant to any of the sample ingredients, iv) not pregnant nor lactating, and v) willing to try the study samples. Both studies required each participant to take part in three sessions. Participants gave written informed consent and were offered a supermarket voucher upon completion of their visits to compensate for their time.

2.2. Experimental design

A total of 109 participants took part in study 1, whereas study 2 included 121 participants. In both studies, participants assessed the samples in the Control (CLT) environment during their first visit to establish a baseline before the introduction of the DIEs. Following this baseline assessment, the order of exposure to the DIEs (DI-congruent and DI-incongruent) was balanced across participants during their second and third visits. Participants completed each environment one week apart and each environment session lasted one hour. Different participants were involved in each study. In both studies, a balanced Williams Latin square design was used to ensure equal representation of samples and to minimize order and carryover effects. Samples were presently monadically in both the studies. In both studies, participants were compensated for their time with a NZD40 supermarket voucher after completing the study.

2.3. Samples

Analysis of veggie balls (Orr, 2024) and ice cream (Poggesi et al., under review) evaluations are reported elsewhere and that data is not included in the current manuscript. Samples are described here for contextual purposes only. In the PB meatball study, participants evaluated veggie balls, one meat-like (formed from Beyond Burger patties, Beyond Meat, California, United States of America), and the other not meat-like (Beetroot, Kumara, and Quinoa Amaze Balls, Food Nation, Auckland, New Zealand) (Orr, 2024). Samples were presented warm in a white ceramic dish, covered with aluminium foil, with a fork, and labelled with a random three-digit code. The veggie balls were rolled and frozen until cooking. They were pan-fried on an induction cooktop (CI604CTB1, Fisher & Paykel, New Zealand) using two tablespoons (approximately 30 g) of canola oil (Harvest NZ, New Zealand). The plant-based meatballs were cooked from frozen until reaching an internal temperature of 75 °C (approximately 10 min). After cooking, the samples were held in a food warmer (E84 Food Warmer, Bakbar, New Zealand) at 60 °C for no longer than one hour prior to serving.In the ice cream study, participants evaluated three mint chocolate ice cream type desserts. One was a dairy ice cream (Double Mint & Dark Chocolate, Lewis Road Creamery, Auckland, New Zealand), one was an ice cream-alternative based on coconut milk (Mint Choc Chip Coconut Ice Cream, Little Island, Auckland, New Zealand), and the third sample was an alternative based on cauliflower (Mint Choc Bikkie Dairy Free Ice Cream, Eat Kinda, New Plymouth, New Zealand). Ice cream samples were presented in a plastic cup with a spoon and labelled with a random three-digit code. Crackers and water were used as a palate cleanser. All samples were stored in a freezer (Skope Reflex, Skope, New Zealand) at a temperature of −21 °C. *prior* to serving, samples were cut into uniform cubes measuring 3*3*3 cm^3 size and subsequently stored in a freezer maintained at −10 °C. The samples were presented to participants at a serving temperature of −10 °C.

2.4. Immersive environments

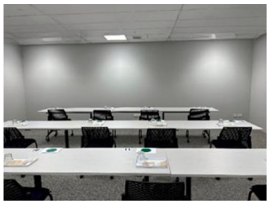
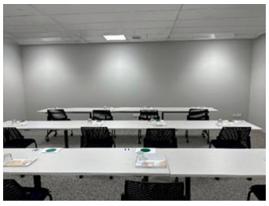
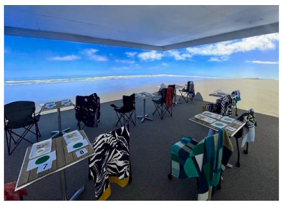
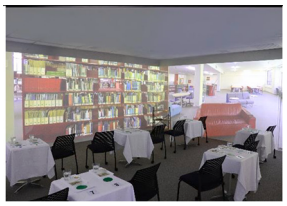
Both studies involved three different consumption contexts: a central location test (CLT) and DIEs congruent and incongruent to the sample category (Table 1). Contexts were selected using an online survey prior to the study, where between 183 and 269 consumers indicated locations in which they were likely and unlikely to consume veggie balls and ice cream respectively. The congruent contexts selected were a home environment for the PB meatball study and a beach environment for the ice cream study. A classical music concert and a library were selected as incongruent contexts for the veggie balls and ice cream study, accordingly. Props were added to the environments to increase the immersive experience. In the home environment a pot plant and television were added, tables were accessorised with white tablecloths, placemats, and salt and pepper shakers (empty); in the beach context, beach towels, beach chairs, and sunscreen containers were spread around the room; in the concert environment seats were covered with red seat covers; and in the library, shelves with books were placed around the room. In all contexts, audio sounds appropriate for the environment were played: a current events television program played in the home DIE context, audio recorded at the beach was played in the beach context, classical music (and video) played in the concert context and muffled background noise recorded in the Massey library was played in the library DIE.

2.5. Survey to determine personality traits and motivation to consume PBMAs

During the first visits participants completed a survey consisting of different published validated questionnaires (Table 2): the Big Five Inventory (John, 1991) which proposes that five dimensions (OCEAN) - openness to new experiences, conscientiousness, extraversion, agreeableness and neuroticism– underlie stable patterns of human behaviour, emotions and cognition; the Life Orientation Test-Revised (LOT-r) (Scheier et al., 1994) which measures dispositional optimism; and the technophilia Questionnaire (Martínez-Córcoles et al., 2017) which is used to understand strong attraction or enthusiasm for using technology. The big five inventory along with measures of technophilia and LOT-r are collectively referred to as personality traits throughout this paper. Although sensory studies have yet to thoroughly investigate how personality traits influence engagement experiences during food evaluation, some insights can be drawn from related fields using virtual reality and DIEs in online learning, games and social media (Bangcuyo et al., 2015; deGraft-Johnson et al., 2013; Rosenthal et al., 2013; Thorp et al., 2023; Weibel et al., 2010).

Elements of each questionnaire were answered using a 5-point scale, ranging from ‘strongly disagree’ to ‘strongly agree’ for the Big Five Inventory, LOT-R, and the Technophobia and Technophilia questionnaire. For each questionnaire, a total score was calculated by summation of individual item scores. The Big 5 and LOT-R questionnaires included reverse score questions, which were inverted for the computed overall score. Furthermore, the LOT-R contained filler items not contributing to

Table 1
Immersive environments used in the PB meatball and ice cream studies.

Environment	PB meatball study (Study1)	Ice cream study (Study 2)
Control (CLT)		
Congruent		
	Home	Beach
Incongruent		
	Concert	Library

the final questionnaire score.

2.6. Engagement in immersive environments

Engagement in all contexts was measured using the Engagement Questionnaire (Bangcuyo et al., 2015; O'Brien & Toms, 2010). The questionnaire contains 21 items, related to eight dimensions: usability, environmental aesthetics, novelty, involvement, sensory awareness, immersion and distraction (Table 3). In the current studies, statements were answered on a continuous scale ranging from −50 to 50. Reverse items were recoded, and the scores for each dimension were calculated by summing items included in the relevant dimension.

2.7. Data analysis

All statistical analysis was conducted in R version 4.4.3 using R Studio software (R Core Team, 2010). Packages *dplyr* and *tidyverse* were used for data wrangling and cleaning and *ggplot2* and *ggpubr* were used for data visualisation (Kassambara, 2023).

To understand the impact of context on engagement dimensions, a repeated-measures design was analysed using linear mixed-effects models fitted via *lme4* package (Bates et al., 2015), which allowed for modelling subject-level variability in repeated observations. Post-hoc pairwise comparisons were conducted using the *emmeans* package (Lenth, 2023) to compute estimated marginal means, with *p*-values adjusted using the Bonferroni correction to control for multiple comparisons.

2.7.1. Relationship between personality traits and engagement in different contexts

To determine the relationship between personality traits and engagement dimensions in different contexts, a linear mixed effects model (LME) was created for each engagement dimension. The eight Engagement Questionnaire dimensions (usability, sensory awareness, novelty, immersion, involvement, sensory aesthetics, realism and distraction) were the response variables and the Personality Traits (extraversion, agreeableness, conscientiousness, neuroticism, openness, Life Orientation Test-Revised (LOT-r) and Technophilia Questionnaire) were fixed factors; participants were included as a random factor. For significant fixed factor effects, further post hoc testing for differences was conducted using Tukey's HSD test.

In both the studies multiple factor analysis was applied to compare engagement dimension scores across the congruent, incongruent and controlled contexts. In addition, to measure the degree of correlation between the contexts, RV coefficients were calculated across all context pairs.

3. Results

3.1. Participants

Mean participant age was 39.6 years (SD = 7.9) in Study 1 and 40.8 years (SD = 12.7) in Study 2. In Study 1, 75.2% of participants were female and 23.9% were male. Similarly, in Study 2, 72.7% of participants were female, whilst 26.4% were male. Dietary patterns in Study 1 indicated that 55% of participants were omnivores, 30.3% were flexitarians, and 14.7% were meat avoiders (vegetarians, vegans, and pescatarians). No information regarding dietary patterns was collected in study 2. All participants were regular consumers of plant-based products, thereby limiting the potential impact of different dietary groups on the study outcome. Participants were asked to rate their familiarity with the products on a 5-point scale where 1 corresponded to *"never heard of it or eaten it"*, 2 – *"unfamiliar I've heard of it but haven't eaten it"*, 3 – *"somewhat familiar – I've heard of it and eaten it a few times"*. 4 – *"familiar I would eat it occasionally"* and 5 – *"very familiar I eat it often"*. Participants who selected 1 and 2 on the scale were excluded from the study.

3.2. Engagement dimensions across contexts

Total engagement scores differed significantly across contexts in

Table 2
Questionnaires to determine participant personality traits.

Name	Instructions	Questions	Scale used
Big Five Inventory (John, 1991)	Please indicate how much you agree with each statement. I see myself as someone who....	Is talkative Tends to fault others* Does a thorough job Is depressed, blue Is original, comes up with new ideas Is reserved* Is helpful and unselfish with others Can be somewhat careless* Is relaxed, handles stress well* Is curious about many different things Is full of energy Starts quarrels with others* Is a reliable worker Can be tense Is ingenious, a deep thinker Generates a lot of enthusiasm Has a forgiving nature Tends to be disorganised* Worries a lot Has active imagination Tends to be quiet* Is generally trusting Tends to be lazy* Is emotionally stable, not easily upset* Is inventive Has an assertive personality Can be cold and aloof* Perseveres until the task is finished Can be moody Values artistic, aesthetic experiences Is sometimes shy, inhibited* Is considerate and kind to almost everyone Does things efficiently Remains calm in tense situations* Prefers work that is routine* Is outgoing, sociable Is sometimes rude to others* Makes plans and follows through with them Gets nervous easily Likes to reflect, play with ideas Has few artistic interests* Likes to cooperate with others	5-point Likert scale from 'Strongly disagree' to 'Strongly agree'

Table 2 (*continued*)

Name	Instructions	Questions	Scale used
		Is easily distracted* Is sophisticated in art, music, or literature	
Life orientation test – revised (LOT-R) (Scheier et al., 1994)	Please indicate how much you agree with each statement.	In uncertain times, I usually expect the best It's easy to relax for me^ If something can go wrong for me, it will* I'm always optimistic about my future I enjoy my friends a lot^ It's important for me to keep busy^ I hardly ever expect things to go my way* I don't get upset too easily^ I rarely count on good things happening to me* Overall, I expect more good things to happen to me than bad	5-point Likert scale from 'Strongly disagree' to 'Strongly agree'
Technophobia and technophilia questionnaire (Technophilia aspects only) (Martínez-Córcoles et al., 2017)	Please indicate how much you agree with each statement.	I am excited for new equipment or technology I am afraid of being left behind if I cannot use the latest equipment or technology I enjoy using new equipment or technology The use of new equipment or technology influences considerably my personal life I think that new technology has a lot of benefits My experience with all the new technologies is positive The use of new equipment or technology influences considerably my personal feelings I feel fear of being left behind if I can't use the latest equipment or technology I have recently acquired new technology I feel loss of control if I can't use the latest equipment or technology The use of new equipment or	5-point Likert scale from 'Strongly disagree' to 'Strongly agree'

(*continued on next page*)

Table 2 (*continued*)

Name	Instructions	Questions	Scale used
		technology affects my relationships	
		I believe that new technology improves life	
		Lately, I have used new equipment or technology too frequently	
		I feel enthusiasm for new equipment or technology due to its novel value	
		I feel restless and worried if I can't use my smartphone	
		I feel enthusiasm when a new technology/product is launched	
		I am afraid of failing if I can't use the latest equipment or technology	
		I have spent more time using new equipment or technology than is reasonable	

* Reverse-coded item (inverted before computing questionnaire score.
^ Filler item (not used to compute questionnaire score).

both studies (Fig. 1). In study 1, total engagement scores were significantly higher in congruent (home) and incongruent (concert) contexts, compared to the control CLT (congruent, $t(216) = -10.41$, $p < 0.0001$; incongruent, $t(216) = -11.04$, $p < 0.0001$), with no significant difference between congruent and incongruent contexts ($p = 1.0$). In study 2, total engagement scores were higher in the congruent (beach) context relative to both the incongruent (library) and control CLT condition (incongruent, ($t(234) = 5.89$, $p < 0.0001$; control, ($t(234) = 9.26$, $p < 0.0001$).

Figs. 2 and 3 show context effects on different engagement dimensions in both Study 1 and study 2. In study 1, a linear mixed-effects model revealed a significant effect of context on usability scores, $F(2,216) = 11.66$, $p < 0.001$. Post hoc comparisons indicated that usability scores were significantly higher in the congruent (home) context compared to the control CLT ($t(216) = 4.42$, $p < 0.001$) and the incongruent (concert) context (t(216 = 3.89, $p < 0.001$). No significant difference was observed between the control and incongruent contexts ($p = 1.0$). Sensory awareness, environmental aesthetics and realism scores were significantly lower in the control context compared to congruent (Sensory awareness, $t(216) = -13.0$, $p < 0.001$; Environmental aesthetics, $t(216) = -10.63$, $p < 0.001$; Realism, $t(216) = -10.13$, $p < 0.001$) and incongruent contexts (Sensory awareness, $t(216) = -12.94$, $p < 0.001$; Environmental aesthetics, $t(216) = -9.20$, $p < 0.001$; Realism, $t(216) = -8.10$, $p < 0.001$). No significant difference was noted between the congruent and incongruent context for sensory awareness ($p = 1.0$), environmental aesthetics ($p = 0.46$) and realism scores ($p = 0.13$). No significant effect of context was observed on novelty scores $F(2,216) = 1.51$, $p = 0.22$). However, context had a significant effect on immersion scores, where congruent contexts had significantly higher immersion scores than the control ($t(216) = 12.96$, $p < 0.001$) but lower compared to the incongruent context ($t(216) = -6.08$, $p < 0.001$). Involvement scores were significantly higher in incongruent contexts than the control ($t(216) = 6.37$, $p < 0.001$), but not significantly different from the congruent contexts $t(216) = 1.49$, $p = 0.41$). However, distraction scores were significantly lower in congruent contexts compared to incongruent $F(2,216) = -2.44$, $p < 0.05$) and control contexts ($t(216) = -4.26$, $p < 0.001$).

Table 3
Engagement and presence questionnaire dimensions, statements and response scales developed by (Bangcuyo et al., 2015).

Dimension	Statement/Question	Anchor Points
Usability	The testing environment assisted in my evaluations of the samples	Strongly disagree - strongly agree
Environmental Aesthetics	The testing environment was appealing	Strongly disagree - strongly agree
	The testing environment engaged my senses	
Novelty	The testing environment made me feel curious	Strongly disagree - strongly agree
	The testing environment distracted me*	
Involvement	The testing experience was boring*	Strongly disagree - strongly agree
	The testing experience was fun	
	I was engaged in the sensory task I performed	
Sensory Awareness	How completely were all your senses engaged by the testing environment?	Not at all - very
	How much did the visual aspects of the testing environment involve you?	
	How much did the sound aspects of the testing environment involve you?	
Immersion	a. I felt like I was in a home/beach [1]	Strongly disagree - strongly agree
	b. I felt like I was at a classical music concert/library [2]	
	I lost track of time.	
Realism	How disconnected did you feel from the testing environment? *	Not at all - very
	How much did your experiences in the testing environment seem consistent with your real-world experiences?	
	How completely did you feel immersed in the testing environment?	
	How involved were you in the testing environment experience?	
Distraction	How aware were you of events occurring in the real world around you? *	Not at all - very
	How quickly did you adjust to the testing environment experience?	
	How much did the testing environment interfere or distract you from performing your sensory evaluation? *	

* Reverse-coded item. Due to the negatively worded question format, values are reversed scored (strongly disagree (50) – strongly agree (−50); Not at all (50) – Very (−50)).
[1] Home/concert was used for the study 1; beach/library was used for the study 2.

In study 2, post hoc comparisons indicated that usability scores were significantly higher in the congruent (beach) context compared to the incongruent (library) context ($t(234) = 4.22$, $p < 0.001$), with no significant difference between congruent (beach) and control (CLT) ($p = 0.38$). For sensory awareness, environmental aesthetics, realism and involvement, congruent context scores were significantly higher than in the incongruent context [Sensory awareness, $t(234) = 5.64$, $p < 0.0001$; Environmental aesthetics, $t(234) = 8.02$, $p < 0.0001$; Realism, $t(234) = 2.52$, $p = 0.04$; Involvement, $t(234) = 6.12$, $p < 0.0001$] and control [Sensory awareness, $t(234) = 14.32$, $p < 0.0001$; Environmental aesthetics, $t(234) = 8.98$, $p < 0.0001$; Realism, $t(234) = 4.54$, $p < 0.0001$; Involvement, $t(234) = 7.30$, $p < 0.0001$]. Immersion scores were significantly higher in both congruent and incongruent context compared to control [congruent, ($t(234) = 13.12$, $p < 0.0001$); (incongruent, $t(234) = 12.02$, $p < 0.0001$)], whilst distraction scores were significantly higher in the control compared to both congruent and incongruent contexts [Beach, $t(234) = 6.37$, $p < 0.0001$; Library, $t(234) = 7.09$, $p < 0.0001$]. However, no significant differences were found between congruent and incongruent contexts for immersion ($p = 0.82$) and distraction scores ($p = 1.0$). No significant differences present in novelty scores between the control and congruent contexts ($p = 0.15$) or between control and incongruent ($p = 1.0$). A significant difference in novelty scores was observed between the congruent and incongruent

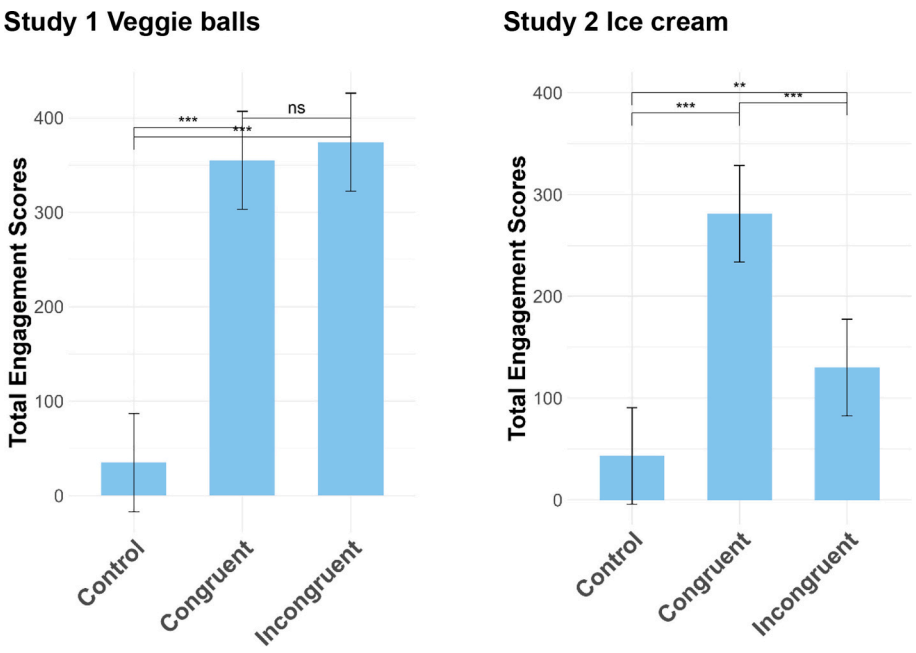


Fig. 1. Total Engagement scored across congruent, control and incongruent contexts of study 1 and 2.
Total Engagement Scores ranged from −1000 to 1000. Scores were calculated by summing the items included across all the dimensions.

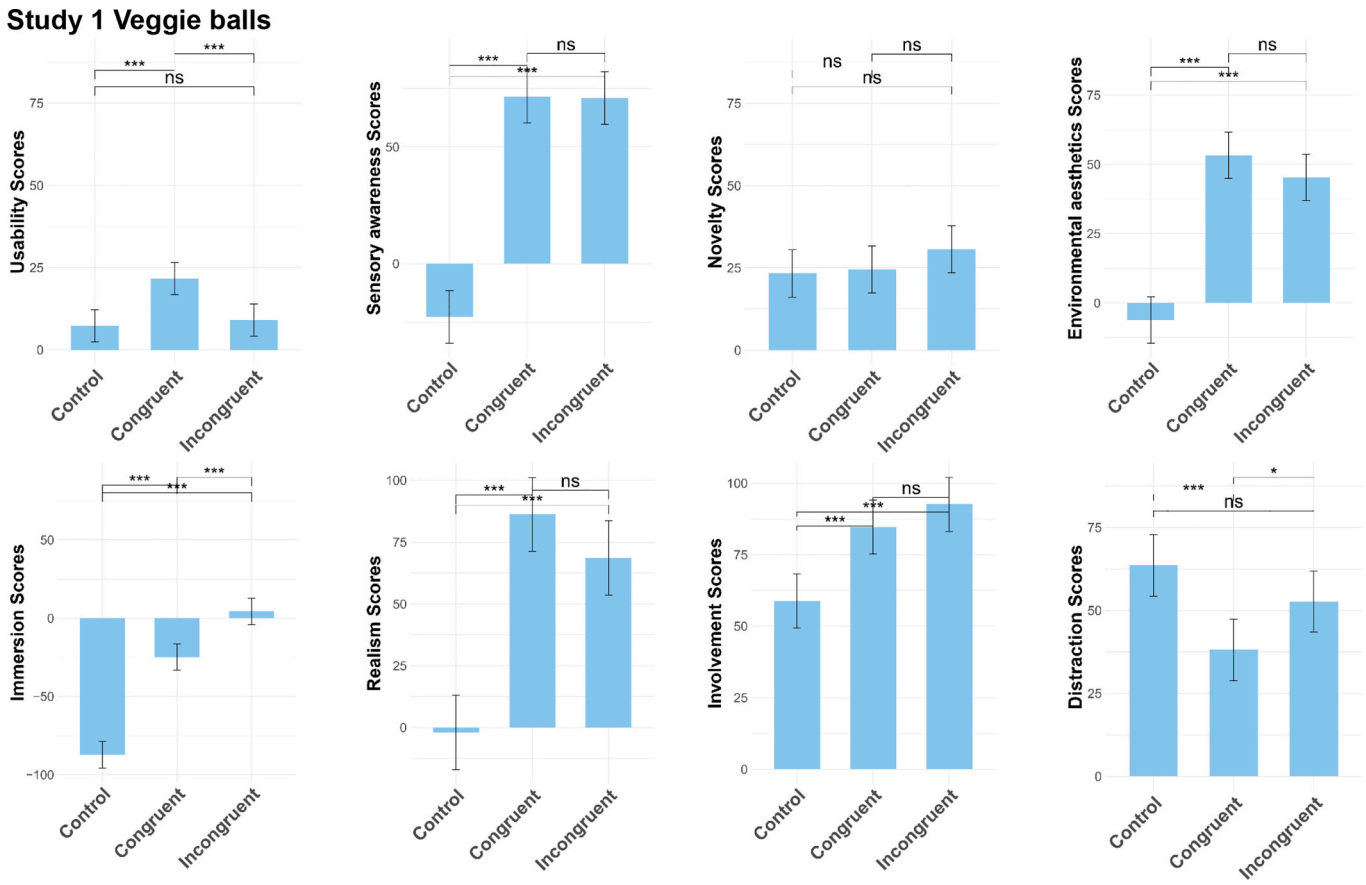


Fig. 2. Repeated measure ANOVA of Engagement dimensions across different contexts (CLT, Home, Concert) in study 1.
Scores for engagement usability ranged from −50 to 50; sensory awareness from −150 to 150; novelty, environmental aesthetics and immersion from −100 to 100; realism from −200 to 200 and involvement from −150 to 150.Scores for engagement dimensions were calculated by summing the statement scores associated with that respective dimension.

contexts ($p = 0.01$).

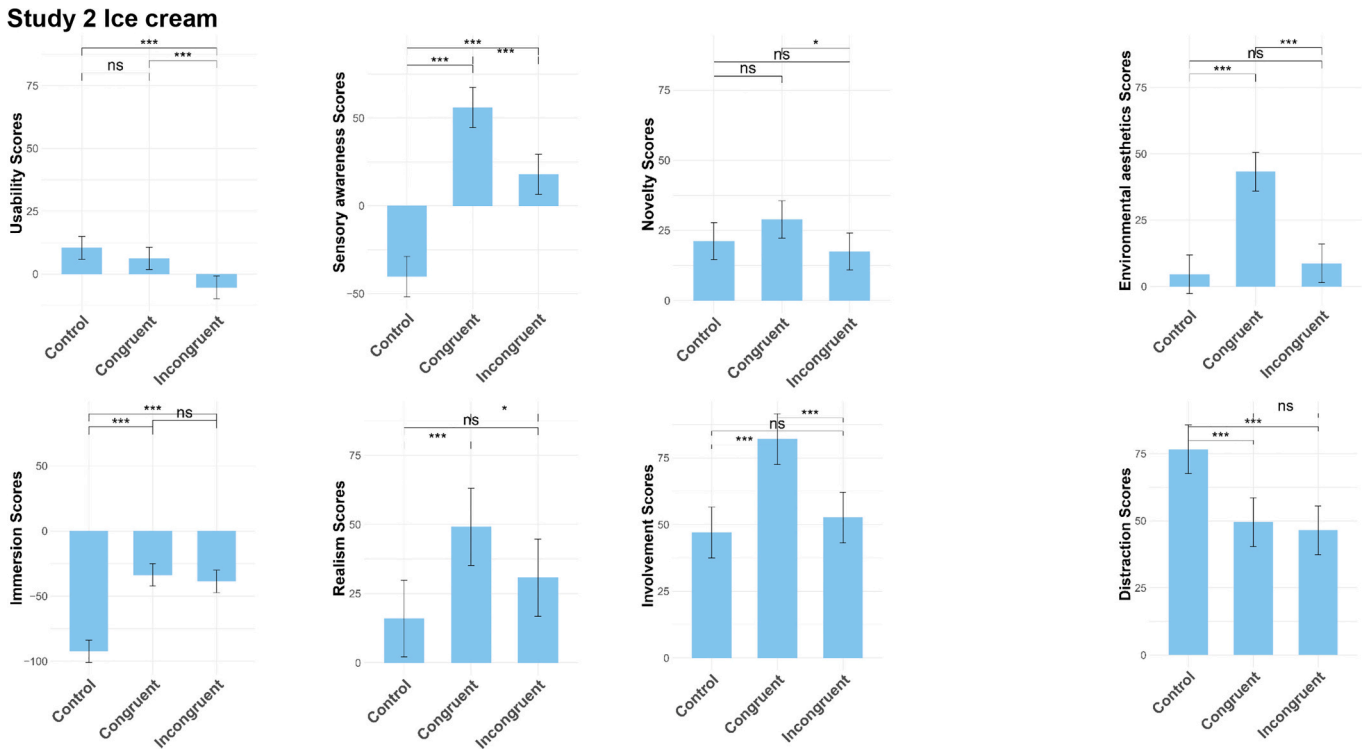


Fig. 3. Repeated measure ANOVA of Engagement dimensions across different contexts (CLT, Beach, Library) in study 2.
Scores for engagement usability ranged from −50 to 50; sensory awareness from −150 to 150; novelty, environmental aesthetics and immersion from −100 to 100; realism from −200 to 200 and involvement from −150 to 150.Scores for engagement dimensions were calculated by summing the statement scores associated with that respective dimension.

3.3. Association between personality traits and engagement in testing environments

Supplementary Table S1 presents the significant main effects of personality traits, as well as interaction effects between context with personality traits scores on the eight dimensions of the engagement questionnaire for both studies. In study 1, *agreeableness* showed significant main effects on environmental aesthetics ($p = 0.04$), involvement ($p = 0.02$), sensory awareness ($p < 0.001$) and realism ($p < 0.0001$). *Neuroticism* showed a significant main effect on novelty ($p = 0.04$), involvement ($p = 0.02$) and sensory awareness ($p = 0.02$). Other factors such as *extraversion, openness* and *conscientiousness* exhibited significant interaction effects with context across different engagement dimensions.

In study 2, *agreeableness* had a significant main and interaction effect on realism ($p = 0.02$). *Technophilia scores* exhibited a significant main effect on environmental aesthetics ($p = 0.01$) and sensory awareness ($p = 0.03$). *Lotr* scores had a significant main effect on Immersion ($p = 0.01$). In addition, *conscientiousness* exhibited significant interaction effects with context on environmental aesthetics, involvement, sensory awareness and realism. Fig. 4 illustrates the significant main effects across eight dimensions of engagement, by personality traits independent of the specific context. In study 1, participants with higher levels of *agreeableness* exhibited higher sensitivity to environmental aesthetics, more sensory awareness, high perception of realism and increased involvement (Fig. 4A–D). Participants with higher *openness to experience* also showed greater sensory awareness (Fig. 4E). In addition, participants with high *neuroticism* gave higher novelty scores, and had increased involvement and sensory awareness (Fig. 4F–H). Participants with higher *technophilia* scores reported higher usability (Fig. 4I). In study 2, higher *technophilia* scores exhibited an increased sense of environmental aesthetics and enhanced sensory awareness (Fig. 4J–K). Higher levels of *agreeableness* were associated with increased realism scores (Fig. 4L). Moreover, participants with low *Lotr* test scores were less likely to immerse themselves than those with higher life orientation scores (Fig. 4M).

Context by personality trait interaction effects indicated that the main effects could not be generalised across all contexts but rather varied depending on specific context (Fig. 5). In study 1, participants with more *openness to experience* showed greater sensitivity towards environmental aesthetics across both the congruent (home) and the incongruent (concert) contexts (Fig. 5A). High *technophilic* participants were more immersed in the control (CLT) than in the congruent and incongruent immersive environments (Fig. 5B) and also perceived higher realism in the incongruent context and control compared to congruent context (Fig. 5C). Participants who scored higher for *extraversion* were more distracted in the incongruent context but less distracted in the congruent context and control (Fig. 5D).

High *Lotr* scores were associated with higher realism and immersion scores in the incongruent context with lower realism and immersion scores in the congruent and control contexts (Fig. 5E–F). Participants who scored higher in *conscientiousness* exhibited greater sensory awareness in the congruent context and low sensory awareness in the control and incongruent contexts (Fig. 5G).

In study 2, participants scoring higher in *conscientiousness*, exhibited higher sensitivity to environmental aesthetics in the congruent (beach) compared to the incongruent (library) and control context (Fig. 5H). Similarly, participants with higher *conscientiousness* scores reported more perceived realism, involvement and sensory awareness in the congruent context than in an incongruent context, followed by the control (Fig. 5I–K). Participants scoring higher in *extraversion* reported more immersion in the congruent context compared to incongruent context, whilst level of immersion scores dropped in the control (Fig. 5L). Participants with higher *openness to experience* rated the congruent context to be more novel than incongruent and control contexts (Fig. 5N). Higher levels of *agreeableness* showed greater perceived realism in both congruent and incongruent context, but lower realism in

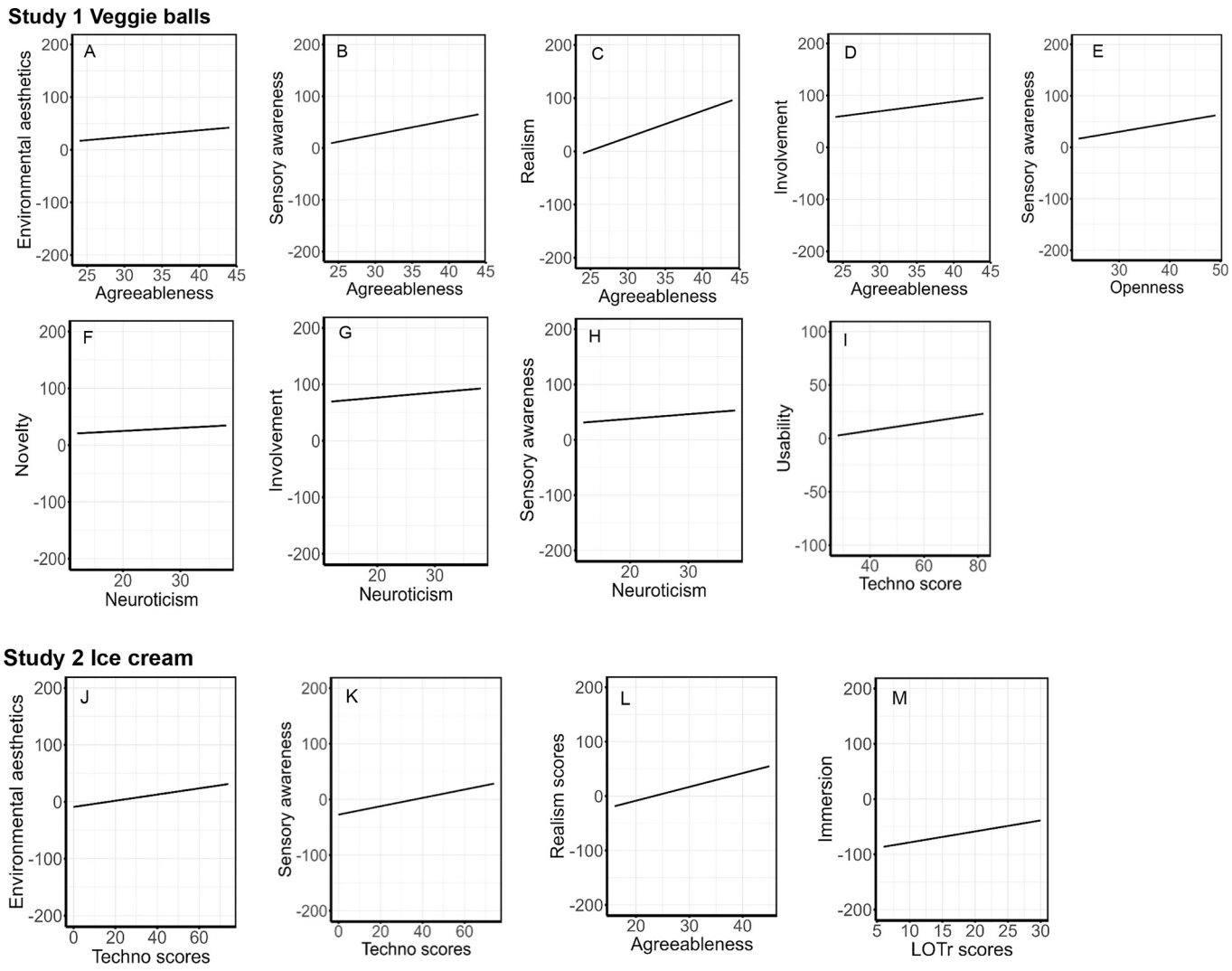


Fig. 4. Main effects of significant personality traits, technophilia and LOT-r on the engagement dimensions (rows).

the control environment (Fig. 5M).

3.4. Comparison across the different contexts for engagement

Fig. 6 shows MFA plots comparing engagement across the different contexts in both studies. The first two dimensions of the MFA plots accounted for 41.45% and 41.83% of the total variance in the dataset for study 1 and study 2, respectively. Based on associated RV coefficients, the contexts exhibit low mutual similarity in both Study 1 [RV(control, incongruent) = 0.12, RV(control, congruent) = 0.06, and RV(congruent, incongruent) = 0.21] and 2 [RV(control, incongruent) = 0.21, RV (control, congruent) = 0.11, and RV(congruent, incongruent) = 0.44)]. However in study 2, the congruent and incongruent contexts exhibited higher similarity compared to in Study 1.

4. Discussion

4.1. Total engagement scores and engagement dimensions across different contexts

In both studies, congruent and incongruent contexts resulted in more engaging, immersive, involved and realistic environments compared to the CLT. The congruent and incongruent immersive environments in both the studies replicated real-world consumption contexts by incorporating external variables such as light, sound and colours that stimulate multiple senses simultaneously (Claman, 2015; Ribeiro et al., 2024). This multisensory stimulation likely enhanced emotional resonance resulting in deeper engagement and immersion scores. On the other hand, the control context was highly task-focused and devoid of any social interactions and external variables (Lawless & Heymann, 2010; Stelick & Dando, 2018), accounting for low sensory awareness and involvement scores. Bangcuyo et al. (2015) also reported similar findings when evaluating different coffee samples in sensory booths versus a virtual coffee shop, with participants showing more engagement and immersion in the virtual environment than in controlled sensory booths. More recently, Ribeiro et al. (2024) also reported that consumers experienced higher levels of engagement, immersion and sense of presence when evaluating peach nectars in augmented virtual environments, such as a public food court and a living room, compared to traditional sensory booths. The findings of the present study align with previous research and contribute to the literature highlighting the significance of external variables such as sound, light and visuals alongside intrinsic product attributes on consumer perception.

Consumer engagement appeared to be influenced by context type, object cues present in the context, and product-context congruency. Study 2 revealed a significant difference in engagement across contexts, the congruent (beach) setting, with immersive elements including beach sounds, sunscreen lotion and other audio and visual props, may have impacted the engagement compared to the incongruent context (library), which lacked the multiple spatial and wider object cues like the

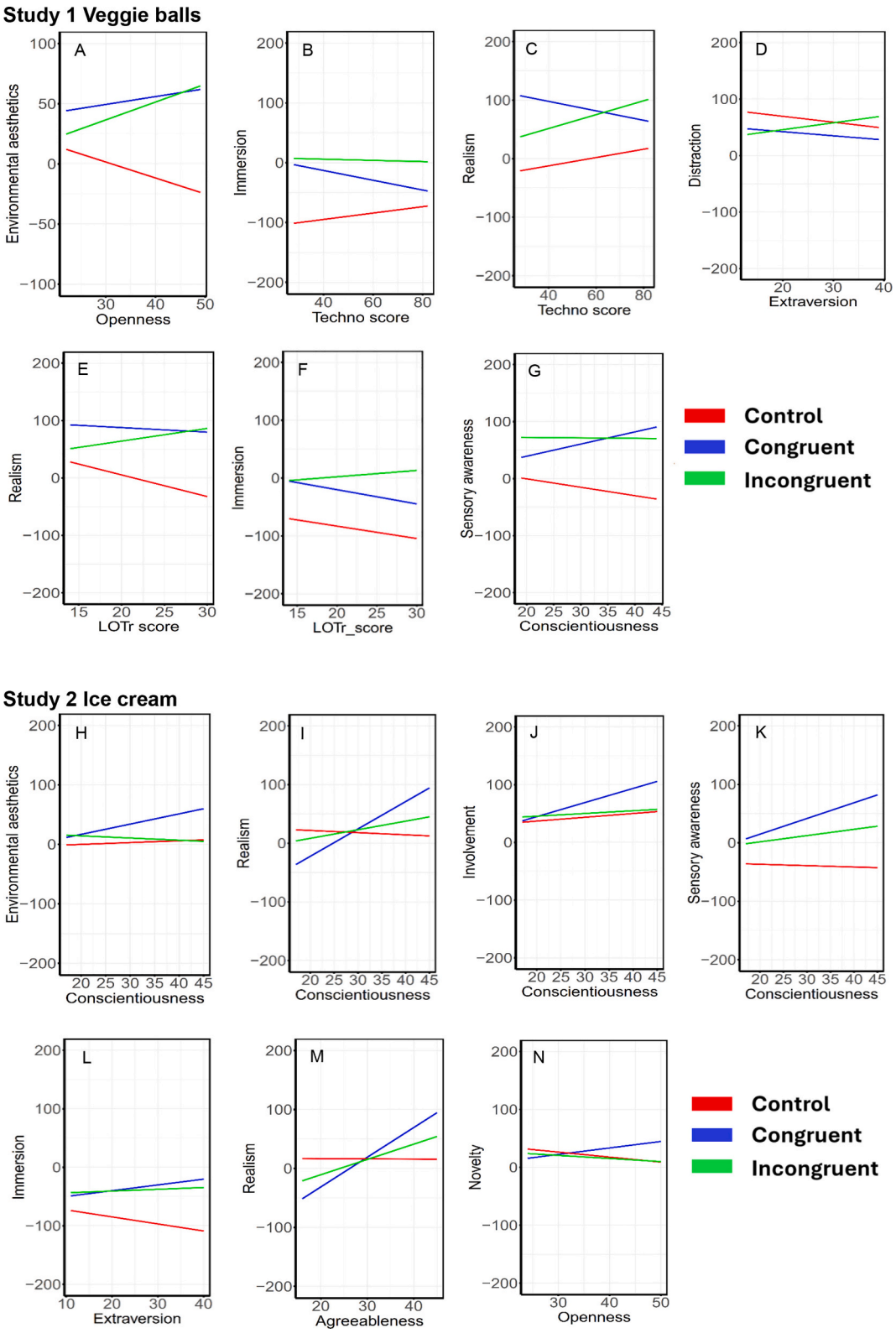


Fig. 5. Interaction effects of personality traits, technophilia and LOT-r on eight engagement dimensions.

beach context. Therefore, engagement may not only have been influenced by the product-context congruency, but also by the types of different spatial and object cues present within the context, further contributing to engagement and hence requires further exploration. The findings are consistent with earlier research in sensory science and psychology, which demonstrated that level of presence in a DIE is influenced by the immersive design elements and number of elemental cues present in the environment (Lee & Kim, 2008; Slater et al., 1994; Slater et al., 2009). Lee and Kim (2008) also reported the impact of spatial and visual cues within an underwater virtual reality environment, revealing that an increased number of spatial and object cues enhanced participant sense of presence and engagement. However,

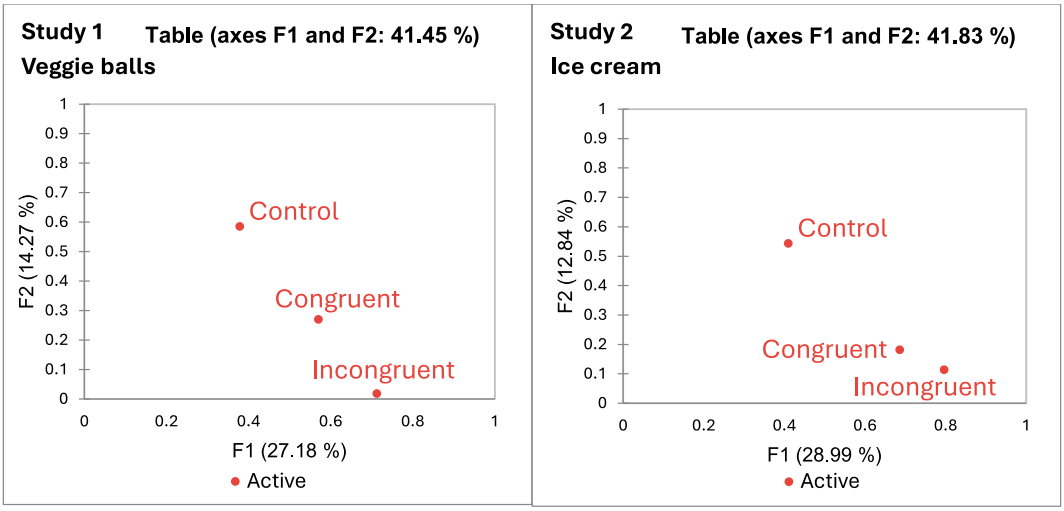


Fig. 6. Representation of average engagement dimensions across three contexts, as examined in studies 1 (Veggie balls) and 2 (Ice cream), based on first two dimensions.

study 1 showed no difference in engagement, immersion or involvement between the congruent (home) and incongruent (concert) contexts. This may be attributed to their similar sensory design where, although different in terms of congruency, both contexts have similar levels of audio and visual props. However, a further plausible explanation is that the participants may not have perceived the home context congruent with their home which could impact subsequent emotional connection (Cristoforetti et al., 2011). Such associations may have conflicted with the experimental setting, causing the home context to be perceived as incongruent, similar to the concert context. This unexpected outcome needs further exploration into how personal relevance and emotional connection influence perceived congruency of contexts, and in particular more personal environments.

In both studies, engagement dimensions also varied across the contexts. In study 1, participants reported a higher level of immersion in the incongruent (concert) context, whereas in study 2, the congruent beach context elicited higher involvement, sensory awareness and perceived environmental aesthetics. Both contexts featured detailed environments with social cues and physical elements which likely contributed to heightened immersion and involvement. In addition, the presence of other participants within the environments may have served as an implicit social cue, further enhancing the perceived realism of the immersive environments such as a concert, beach and library. However, a home is a personal space, where the presence of unfamiliar participants might also have influenced responses and affected ecological validity. Therefore, future studies should further examine how social cues within immersive environments shape participants' engagement. These findings highlight the key role of the immersive context in shaping consumer engagement within DIE-based research settings. This effect may be driven by the richness of audio-visual stimuli and the level of physical cues used, along with the digital projection and type of context, which also contribute to a more coherent and engaging participant experience (Dinh et al., 1999).

Previous research has shown that the novelty of DIEs strongly influences novice users (Hannum et al., 2020; Lee et al., 2020; Lee et al., 2025; Merchant et al., 2014) but that repeated exposure to these environments leads to reduced engagement (Hannum et al., 2020). Novelty was not significantly different between the control and immersive environments in the studies reported here. A plausible explanation for this is the diminishing effect of initial curiosity as users become more familiar with the technology (Tsay et al., 2020). Given that the Feast lab has been conducting digital immersion studies for the past three years, many participants may have been exposed to the technology previously reducing the novelty effect. These findings highlight the need for future research to explore how the novelty of the immersive context influences consumer experiences over time, and how repeated exposure through continuous visits impact consumer behaviour and product evaluation.

Interestingly, participants reported being more distracted in the CLTs compared to in the immersive environments in the present study. This finding is counterintuitive, as sensory booths are designed to minimize external variables and provide a highly controlled setting (Giezenaar & Hort, 2021; Torrico et al., 2023), which would typically be expected to reduce distraction. In contrast, immersive environments are characterised by multisensory stimulation, which is generally assumed to increase intrinsic motivation and cognitive load (Breves & Stein, 2023; Wenk et al., 2023) and potential for distraction. Notably, previous research has consistently demonstrated that participants tend to be less distracted in controlled booth environments than in immersive settings (Hathaway & Simons, 2017; Sinesio et al., 2019), making the current findings particularly unexpected and in need of further exploration. One possible explanation for the reduced distraction in the DIEs might be the growing familiarity of participants with immersive experiences in the Feast laboratory. Such familiarity may enable participants to adapt easily and perceive these environments as a natural component of the investigation rather than a source of distraction.

Usability scored consistently high in the congruent immersive environments across both studies. This aligns with existing literature that congruency between products and the test environment significantly enhances consumer engagement, and validity of the evaluation outcomes (Dijksterhuis et al., 2005; Hoegg et al., 2010; Trivedi & Khanum, 2012). These outcomes are more pronounced when the evaluation context closely relates to the natural setting in which the product is typically used – such as home for veggie balls and beach for ice cream, encouraging deeper user engagement and more authentic interactions (Wenk et al., 2023; You et al., 2023). You et al. (2023) also reported that in virtual shopping experiences, displaying products within their actual usage space enhances consumer ease of selection and boosts confidence in making purchase decisions. Similarly, in both studies, the congruent home and beach contexts were commonly associated with veggie balls and ice cream respectively and this contextual relevance likely contributed to their high usability scores.

4.2. *Effect of personality traits on engagement dimension scores*

Personality traits significantly influenced engagement dimension scores in the current studies, emphasising the importance of considering individual personality differences when designing and interpreting DIE-based consumer studies. *Agreeableness* and *neuroticism* were the main

personality traits affecting engagement dimensions in study 1 whilst *technophilia* had a significant effect on environmental aesthetics and sensory awareness in study 2. Individuals characterised by the *agreeableness* trait—typically described as friendly, cooperative, empathetic, and altruistic, appeared more willing to suspend disbelief and adapt to the DIE. Their prosocial disposition may facilitate deeper emotional and cognitive involvement (Chacón et al., 2024; Trå et al., 2022), enhancing their overall immersive experience (Ma, 2020). Sacau et al. (2005) also state that those exhibiting higher levels of *agreeableness* were found to experience significantly greater spatial presence and involvement in a virtual environment, which was also observed in study 1.

In study 1, participants with high *neuroticism* scores were found to be more immersed and sensory aware. One possible explanation is that individuals high in *neuroticism* tend to be more nervous, insecure and reactive to new or stressful situations. This heightened sensitivity often makes them more observant and aware of the surroundings, which can lead to deeper involvement (Limura & Yano, 2024), as seen in study 1. Supporting this, an online survey with 220 participants examined the impact of personality traits on immersion in a new online gaming experience and indicated that *neuroticism* is positively related to immersion tendency. Specifically, individuals higher in *neuroticism* tend to experience more emotional involvement when engaging with immersive environments (Weibel et al., 2010).

Openness to experience emerged as a significant trait influencing participant sensory awareness in study 1. Characterised by intellectual curiosity, aesthetic sensitivity and preference for new experiences (McCrae & Costa, 1983), individuals high in *openness* exhibit more sensory awareness (Roos & Kazemi, 2022; Wong et al., 2023). The present findings align with existing literature suggesting that individuals more open to experience are usually creative and more involved in sensory rich environments such as online shopping platforms (Roos & Kazemi, 2022) or aesthetically appealing online blogs (Fullwood et al., 2015). Their enhanced aesthetic sensitivity and focused attention further amplify engagement in the sensory-rich contexts (Chang et al., 2018).

Interestingly, in study 1, usability was only influenced by *technophilia* scores. This finding diverges from previous research on personality traits and perceived usability in virtual environment studies and online Learning platforms, which indicated that usability is influenced not only by technophilic tendencies but also by broader personality traits, such as *openness to experience*, *conscientiousness*, *extraversion* and *neuroticism* (Kortum & Oswald, 2018; Vlachogianni & Tselios, 2022; Zekry & McKee, 2023). Heryadi et al. (2016) revealed that user experience in virtual gamification was more strongly associated with personality traits than with demographic factors such as age or gender. For instance, individuals *high in openness* often exhibit more favourable usability outcomes due to their adaptability and willingness to engage with novel interfaces, whereas those high in *neuroticism* may experience increased anxiety when faced with usability challenges (Kortum & Oswald, 2018; Zekry & McKee, 2023). However, findings from the current studies disagree with the broader literature. This outcome may be attributed to the study's design, which may have reduced the influence of personality. Unlike interactive settings such as virtual reality games, participants in this study did not directly engage with the congruent and incongruent environments. Instead, these environments served purely as contextual backdrops designed to simulate real-life experience. Additionally, participants received clear instructions prior to the evaluation, to help them understand their task. Previous literature based on virtual gaming studies has also indicated that when a study is straightforward, well-structured, and guided by robust usability principles, it can reduce cognitive load and emotional strain, thereby attenuating some effects of individual personality (Norman, 2013; Novak et al., 2000; Tuch et al., 2012).

Similarly, dispositional optimism, as measured by the *LOTr*, was found to enhance immersion in the present study. One possible explanation is that optimism and positive mood facilitate cognitive processes such as attention and engagement (Karhu et al., 2022), which may, in turn, heighten sense of immersion in a virtual environment. Although this investigation did not directly measure dispositional optimism, findings from Getenet et al. (2024) suggest that a positive attitude towards digital technology can significantly enhance immersion and engagement in digital learning environments. Whilst many existing studies have utilised virtual environments as tools to improve mood (Diniz Bernardo et al., 2021; Pavic et al., 2023; Somarathna et al., 2022), a notable gap in the literature exists in that not many studies have specifically examined how positive attitude, optimism, or behavioural mindsets directly contribute to enhanced immersion or presence within VR. This highlights the need for further research exploring psychological traits that may predispose individuals to more immersive experiences in the virtual environments.

4.3. *Influence of personality traits on engagement dimensions across different contexts*

The present studies revealed that different personality traits significantly influenced environmental aesthetics, realism, involvement, sensory awareness, immersion, novelty and distraction, but effects varied depending on context congruency in which engagement occurred, highlighting a complex interplay between personality traits and contextual factors.

Both studies highlighted the role of *conscientiousness* in shaping sensory awarenessacross different contexts. Participants high in *conscientiousness* reported greater ‘sensory awareness’ in congruent compared to incongruent contexts. However, in study 2 this only applied to heightened perceptions of involvement and environmental aesthetics. This aligns with Naderi et al. (2020) who suggest that conscientious individuals are more attuned to environmental cues that align with task-relevant goals, consistent with theories of predictive processing and environmental congruence (Spaak et al., 2022), which state that congruent contexts facilitate more effective cognitive and perceptual engagement. A similar influence of conscientiousness has been observed on food choices and eating behaviour studies (Heaven et al., 2001; Keller & Siegrist, 2015). Research suggests that ability of conscientious individuals to regulate emotions and maintain focus on long-term goals, offers a deeper understanding of consumer food preferences (Shanahan et al., 2014). It will be interesting to explore further how this personality traits shapes engagement and product evaluation within DIEs in the future sensory studies.

In study 2, participants with high levels of *conscientiousness* perceived the congruent environment as more realistic, whereas no such effect was observed in Study 1. Similarly, participants who scored higher on the *LOTr* scale perceived the home DIE as less realistic and immersive. One possible explanation is that the home environment used in Study 1 was not like the participant's actual homes, making it difficult for them to connect with the context. Psychological research has shown that the home carries strong symbolic and psychological significance, often serving as an extension of personal identity and self-expression and any changes in one's personal context such as home can affect cognitive and emotional states (Graham et al., 2015). Thus, despite being a thematically congruent home environment, the lack of familiarity to their own home could be the behind observed lower perceived realism and immersion. These findings further underscore the importance of considering the specificity of more personal environments, like the home when evaluating consumer perceptions in digital immersive environments.

In Study 1, participants with high *technophilia* scores reported reduced immersion in DIEs particularly when exposed to a congruent context followed by an incongruent one but increased immersion in the CLT environment comparatively. This finding underscores the influence of contextual consistency on immersive experiences. Technophilic individuals exhibit a strong enthusiasm for technology, especially emerging innovations, and often thrive in dynamic, sensory-rich environments (Barrientos-Gutierrez et al., 2019). The concert context,

despite being incongruent, offered rich and dynamic sensory stimuli (e.g., crowd noise, stage visuals) that likely align with the expectations and preferences of technophilic individuals. Similar findings were also reported by Man et al. (2023) that consumer reported a stronger sense of presence and immersion in the less familiar, yet lively virtual environment compared to the congruent environment when evaluating granola bars. A familiarity assessment was not conducted in either study, limiting the ability to evaluate the influence of contextual familiarity on participant responses across conditions. As familiarity is closely linked to emotional engagement and perceived congruency (Garcia-Marques et al., 2016; Guilbert et al., 2020), its omission represents a methodological constraint. Future research should explicitly incorporate familiarity measures for each context to disentangle familiarity effects from contextual congruency. Doing so would strengthen internal validity by controlling or including a familiarity-based variable and enable more accurate and reliable conclusions regarding how contextual familiarity shapes emotional and perceptual outcomes. Additionally, while the home environment was contextually congruent, it lacked immersive qualities like concert environment and did not accurately reflect the participants' actual home environments. This may have resulted in lower immersion and underscores the importance of considering situational appropriateness (Giacalone, 2019; Giacalone & Jaeger, 2019), which refers to the alignment between a product and its real-world usage context (in this case participant's own home). This highlights the crucial role of both the type of context and the level of presence and immersion in DIEs, which must be carefully considered when designing such studies. It will be interesting to investigate the impact of individualised, consumer-tailored contexts (e.g., personal home environment) on their sense of immersion in future studies.

In study 2, participants with higher levels of *extraversion* reported greater immersion in DIEs, whereas in study 1, they experienced more distraction in the incongruent concert setting compared to the congruent home setting. While sensory science has yet to extensively explore the influence of personality traits on engagement dimensions and product evaluation, insights from other fields such as online learning and games in DIEs, offers valuable perspectives. Existing literature suggests that *extraversion* (Ghafoori et al., 2024; Schuster, 2024; Weibel et al., 2010), characterised by assertiveness and high levels of social engagement, experience more immersion and presence when exposed to pleasurable media content and interactive environment such as online games. Extraverted individuals are more inclined to explore technology (Davis, 1989; McFarlane & Latorella, 2002), particularly when it features high environmental aesthetics and rich sensory stimuli, which leads to greater emotional involvement and deeper immersion in DIEs (Weibel et al., 2010), as seen in study 1. However, in study 2, the incongruent concert context introduced unfamiliar contextual sensory experience and novel food-context experience, unlike the congruent home setup or the controlled environment. For extravert participants, this heightened sensory engagement may have amplified immersion but also led to increased distraction, as they are more likely to shift focus away from their primary task in such stimulating environments (McFarlane & Latorella, 2002).

4.4. Limitations

This is the first study to understand the impact of different personality traits on the level of engagement and immersion in the product-congruent environment. However, some limitations to the research can be acknowledged. The participant sample was disproportionately represented by female participants, which is a common occurrence in the sensory studies and may have influenced the study's outcome (Da Silva et al., 2014). Previous research has shown that personality traits can vary by gender (Costa Jr et al., 2001). Women tend to report high in *neuroticism*, *agreeableness*, warmth and *openness* to feelings, while male are reported to be more assertive and openness to ideas (Costa Jr et al., 2001). Therefore, investigating whether the current findings are also influenced by gender represents an important direction for future research.

Participants were unfamiliar with the specific contextual environments used in the present studies. However, they may have had prior exposure to other immersive environments in earlier studies at Feast. Additionally, the presence of unfamiliar participants within the environment may have further influenced ecological validity and individual engagement. Future research should explore how engagement responses differ among participants experiencing such immersive contexts for the first time, as well as how the presence of other individuals shapes engagement in such environments. Additionally, although participants identified the home setting as the congruent environment in the pre-survey, it would be valuable to assess whether this perception of congruency is maintained during or after the immersive evaluation. Incorporating in study or poststudy measures of perceived context congruency would enable a clearer understanding of how subjective interpretations influence engagement outcomes. Despite efforts to achieve high ecological reliability, virtual environments necessarily simplify or abstract real-world dynamics, which represents a further limitation of the current work. Finally, although self-reported engagement questionnaires are widely used and accepted in immersive research, they remain susceptible to response bias, as participants often lack direct insight into their emotional states and instead base their answers on beliefs, expectations and contextual cues (Gao et al., 2021). Complementing subjective measures with behavioural or physiological indicators would strengthen the robustness of future investigations.

4.5. Research and industrial implications

The present findings reinforce the importance of accounting for individual differences when studying engagement in digital immersive environments. While contextual congruency influenced engagement outcomes, these effects were not uniform across participants, suggesting that personality traits play a meaningful moderating role. This supports theoretical perspectives that position engagement as an interaction between environmental affordances and individual psychological characteristics, rather than as a purely stimulus driven response (Kober & Neuper, 2013; Laarni et al., 2004). Future immersive research would benefit from integrating personality measures in the studies, allowing researchers to better identify how and for whom immersive contexts enhance engagement and more reliable results.

For industry testing, our findings indicate that valuable insights into consumer engagement can still be obtained even when true home environments have limitations. Digitally simulated, product congruent immersive environments provide a practical alternative, capturing key contextual aspects of real-world consumption while offering the control, scalability, and cost efficiency required for commercial research. Although a simulated home has limitations, they likely still support congruency research when researchers carefully consider the type of home being modelled and enhance ecological validity, with particular attention given to how well the digital home environment aligns with an individual's actual home. Importantly, our results also show that engagement is influenced not only by context but also by individual personality traits, underscoring the need for industry practitioners to consider consumer heterogeneity when designing and interpreting immersive studies such as adjusting sweetness thresholds across products or providing familiar setting for texture-modified meals. Rather than relying solely on physically accurate home settings, industry testing can benefit from strategically designed immersive environments that align with product use contexts and are tailored to target consumer segments. This approach enables flexible, reproducible testing while still capturing psychologically meaningful aspects of real-world consumption.

5. Conclusion

Product-context (in)congruency and certain personality traits significantly influenced consumers engagement and its different dimensions. The findings indicate that, beyond product-context congruency, the type of the context also plays a crucial role in shaping engagement levels. Personal contexts, such as a home environment may still feel incongruent despite aligning with product-context congruency, thereby affecting consumer engagement. Additionally, the levels of visual and elemental cues across different contexts appear to influence engagement levels. However, more systematic research is needed to understand how these environmental cues affect consumer engagement during sensory evaluation. Notably, consumers reported higher engagement and immersion in DIEs and were less distracted compared to control environment, which needs further exploration to understand the reason behind this.

Personality traits such as *agreeableness* and *neuroticism* were found to impact involvement, sensory awareness and perceived realism dimensions. *Technophilia* was strongly associated with usability, whilst more conscientious participants, who are typically more detail-oriented, showed heightened sensory awareness in congruent environments across both studies. These findings suggest that product-congruent environments may enhance the strengths of certain personality traits, leading to a more detailed and attentive evaluation style. Notably, this study is the first within sensory science to explore the influence of personality traits on engagement within digital product-(in)congruent contexts. These individual differences merit further exploration to better understand their role in shaping product evaluation and user experience in immersive settings.

CRediT authorship contribution statement

Annu Mehta: Writing – review & editing, Writing – original draft, Formal analysis. **Caroline Giezenaar:** Methodology, Data curation, Conceptualization. **A. Jonathan R. Godfrey:** Writing – review & editing, Methodology, Formal analysis, Conceptualization. **Rebekah E. Orr:** Writing – review & editing, Methodology. **Simone Poggesi:** Writing – review & editing, Methodology. **Meika Foster:** Writing – review & editing, Methodology. **Joanne Hort:** Writing – review & editing, Supervision, Methodology, Funding acquisition, Formal analysis, Conceptualization.

Ethical statement

The study was submitted to the Massey University Human Ethics process. The Plant-based meatball study was judged to be low risk (Application ID 4000027702), while ice cream study received a full ethics approval (Application ID OM1 23/48).

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.foodqual.2026.105900.

Data availability

The data that has been used is confidential.

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