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Exploring the Interplay of Pro-Environmental Attitudes, Dietary Choices, and Packaging Preferences: A Virtual Reality Restaurant Scenario Study

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Abstract: This research paper delves into the complex relationship between pro-environmental attitudes, dietary preferences, and packaging choices using a Virtual Reality (VR) restaurant scenario. The imperative is to address environmental concerns, particularly plastic waste and greenhouse gas emissions, as they pertain to sectors of the food service sector. This study seeks to understand the factors influencing environmental attitudes and behaviors, with a focus on dietary preferences and packaging choices using a VR restaurant scenario. This study explores connections between gender, education, interventions, and pro-environmental attitudes, as well as the correlation between vegetarian diets and sustainable behaviors. While the results suggest significant correlations between gender and pro-environmental attitudes and a potential connection between adopting vegetarian diets and pro-environmental attitudes, our study emphasizes the nuanced nature of these relationships. The findings underline the importance of interdisciplinary research and strategic interventions for fostering sustainable behaviors and reducing environmental impact. The use of VR simulation adds a novel dimension to understanding individuals' choices in controlled environments, shedding light on the intricate dynamics of pro-environmental decision making. This paper contributes to the ongoing discourse on sustainable behavior by offering insights into the interplay between personal preferences, environmental awareness, and choices with significant environmental implications.

Keywords: pro-environmental attitudes; dietary choices; packaging preferences; Virtual Reality (VR) simulation; food service industry



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1. Introduction

The escalating environmental challenges of our time demand urgent action, placing a spotlight on critical issues such as plastic waste and consequential greenhouse gas emissions [1,2]. Recent studies underscore the alarming trajectory of plastic pollution, which is expected to inflict severe damage on natural ecosystems and compromise air and soil quality [3]. Among the industries contributing significantly to these challenges, the food service sector stands out for its notorious generation of single-use plastic waste. Food and beverage packaging alone accounts for approximately 15% of total plastics produced since the 1950s [4].

While commendable strides have been made in certain areas, e.g., the transition to digital receipts, paper straws, and alternatives to plastic packaging, as well as the emergence of environmentally related labeling on food products, the pressing need for effective, behavioral interventions remains [5,6]. Within the food service sector specifically, restaurants play a pivotal role in bridging material innovations with consumer behaviors and

can act as change agents in enacting strategies [7]. However, achieving transformative change requires a deeper integration of core environmental attitudes that influence consumer behaviors. This monumental task mandates a profound introspection into what truly drives green lifestyles and a rigorous evaluation of the multitude of factors influencing eco-decisions. These factors are not limited to, but certainly encompass, socio-economic backgrounds and personal attributes, each playing its pivotal role in shaping attitudes [6,7].

Publications in the literature spanning various disciplines consistently elucidate the interplay of personality, demographics, and foundational environmental attitudes, offering pivotal insights into sustainable consumption patterns [8–11]. An interesting nuance emerges when one delves into the role of age: though not always a strong standalone predictor of eco-consciousness, younger digital-native cohorts seem to exude a heightened sense of responsibility towards sustainable practices [12]. Further compounding this, there is robust evidence pointing towards a correlation wherein individuals from elevated educational and economic echelons lean more towards environmentally friendly behaviors [13,14]. Intimate familiarity with environmental issues can act as a potent catalyst, triggering more aligned behaviors [15]. When we navigate the domain of gender studies, a pattern crystallizes: there seems to be a female propensity towards eco-conscious behaviors, a phenomenon shaped by an amalgamation of societal imprints, gender roles, and unique concerns spanning reproductive health and beyond [16–19]. Additionally, the nexus between vegetarianism and pro-environmental behavior is intricate, yielding mixed research outcomes. Although vegetarianism does not universally signify heightened awareness of environmental health [20], evidence indicates that adopting a vegetarian diet, compared to a meat-based one, can lead to reduced greenhouse gas emissions [21]. Additional studies have highlighted that a considerable proportion of the population exhibits hesitancy towards pro-environmental measures, often stemming from either a propensity to prioritize short-term gains or a potential lack of awareness regarding their environmental impact [22]. This is further exacerbated by a prevailing sentiment wherein individuals often deflect personal accountability towards larger institutional entities, a sentiment that becomes entangled with economic constraints that might hinder sustainable decisions [23]. There is also a bias coming from self-identification, which needs to be considered in the understanding of these trends [6].

As the world hurtles towards technological advancements, emerging tools and methodologies, like “nudging”, present themselves as formidable allies in our journey towards sustainability [24,25]. Nudging is a tactical concept from behavioral economics that refers to making small, subtle changes to the environment or decision-making processes to encourage or “nudge” people towards making more sustainable choices [24]. It can change behavior and attitudes without limiting choices or mandating actions [26,27]. Nudging with messages about the impact of plastic waste has also been used in many contexts [28]. It has been used specifically to reduce plastic use, e.g., to reduce plastic bag usage in supermarkets [29]. Nudging has also been researched within the context of plastic pollution by referencing its detrimental effects on oceans and aquatic life [24]. However, different types of nudges may be more effective for different groups than others, particularly concerning gender [25].

Technological advancements in Virtual Reality (VR) enable realistic simulations of food-shopping scenarios, providing an accurate platform to evaluate influences on consumer choices [30]. As research in this area grows, VR is set to become a key tool in promoting sustainable food consumption, presenting rich insights for both researchers and policymakers. However, integrating VR into studies requires careful attention to avoid introducing biases from the immersive environment [31]. Factors such as the language used and the visual cues presented in VR can sway participants’ perceptions, potentially affecting the study outcomes. Furthermore, personal attributes like individual past experiences, educational background, age, and familiarity with the items under study can lead to varied interpretations. This emphasizes the importance of designing VR experiences based on sound research to minimize unintended biases. Nonetheless, a certain level

of subjectivity remains unavoidable in crafting and deploying VR scenarios, given the inherent personal touch involved in the design process. By delving into the attitudes and behaviors of consumers in a virtual restaurant scenario, this research aims to contribute valuable insights. As the field of research utilizing VR technology expands, it is poised to become a key tool in promoting sustainable food consumption, offering rich insights for both researchers and industry decision makers. The objective of this study is to explore potential disparities in pro-environmental behaviors among individuals based on their dietary preferences and packaging selections when they make takeaway purchases at restaurants. This investigation formulated the following three hypotheses pertaining to environmental attitudes and behavior:

H1: *Primarily, we posit that attitudes towards environmental action are intrinsically connected to demographic factors including age, gender, and education;*

H2: *Secondly, the study hypothesizes that environmental attitudes correlate with choices related to diet and packaging;*

H3: *Lastly, it is postulated that interventions geared towards heightening environmental awareness will yield a positive transformation in consumer selections towards less plastic and more sustainable menu items.*

To scrutinize these hypotheses, a VR restaurant scenario was orchestrated, wherein participants' selections were evaluated through a choice. Half of the respondents were presented with a warning message of an animal hurting from plastic exposure, while the control group did not see this cue. All participants were asked to provide responses to established scales measuring environmental literacy, responsibility, and willingness to embrace eco-friendly consumption.

2. Methods

This study utilized a VR experiment, simulating a takeaway restaurant environment, to explore consumer behavior and attitudes related to environmental sustainability. In this section, we detail the experiment's design, wherein participants, divided into intervention and control groups, engaged in a choice-based tasks within our immersive VR setup, followed by a survey incorporating key measures to assess the outcomes.

2.1. Virtual Reality Experiment

Incorporating the immersive potential of VR, this study unfolded within a simulated setting resembling a takeaway restaurant for order collection. The VR experience initiated with participants virtually embarking on a journey from their own homes to a modest eatery. Alongside the participants' demographic particulars encompassing age, gender, and educational background, an intervention group of half of the participants received a cautionary infographic about the detrimental impact of plastic waste on ocean ecosystems (depicted in Figure 1).

Following exposure to potential interventions and completion of self-assessment tasks, participants immersed themselves in a VR scenario that replicated a restaurant's ordering process (illustrated in Figure 2). The virtual environment faithfully recreated the ambiance participants would encounter in an actual restaurant. In this context, a virtual waiter engaged participants in two choice-based tasks. The initial task required them to select from meal options: vegetarian, fish, or meat-based. Subsequently, the second choice involved their preference for packaging materials for the takeaway meal, offering a selection between recyclable and non-recyclable plastic.



Figure 1. Screenshot of image from plastic warning infographic (adapted from <https://www.istockphoto.com/pt/foto/plastic-pollution-in-ocean-turtle-eat-plastic-bag-environmental-problem-gm1131217734-299458345?phrase=ocean+plastic&searchscope=image,film>; accessed on 12 January 2021).



Figure 2. Screenshot of Virtual Reality (VR) Restaurant. The virtual application was developed in Unity 2020.3.25f1 (Unity Technologies, San Francisco, CA, USA, <https://unity.com>).

2.2. Measurement of Attitudes

After the VR simulation, in order to evaluate participants' stances on environmental concerns and sustainable practices, this study employed three scales: the perceived seriousness of environmental behavior (PS), perceived environmental responsibility (PER), and green purchase intention (GPI) scales [32]. Respondents rated a series of statements on a 7-point Likert scale, ranging from "totally disagree" to "totally agree". Higher scores indicated stronger pro-environmental inclinations.

2.3. Benefits and Limitations

This study harnessed the synergy between VR simulations and questionnaires to garner tailored data and attitudes for choice-based experiments. This approach facilitated the exploration of how demographic variables and personality traits influence consumer decisions and pro-environmental attitudes. VR simulations offered a cost-effective means of creating quasi-realistic scenarios with precise control over responses. However, it is important to acknowledge the inherent reliance on self-assessment, the time-intensive nature of in-person procedures, and the potential for divergent choices influenced by real-world factors like price and social pressures.

2.4. Hypothesis Tests

To ascertain reliability, Cronbach's Alpha measures were applied to the three green attitude scales. A threshold of 0.6 was selected, based on a general consensus of this being a sufficient condition [33].

On the rationale of a small sample size and detected lack of normal distribution, the means of attitude scales were compared with Mann–Whitney tests. This was repeated for all three scales and the subgroups (i) Gender (Female vs. Male), (ii) Education (Undergraduate vs. Graduate), (iii) Message (Intervention vs. Control), (iv) Meal Choice (Plant- vs. Animal-based), and (v) Package Choice (Recyclable vs. Non-recyclable). Two-sided hypotheses with a significance level of 0.05 were used. For the connections between Meal Choice–Gender, Meal Choice–Intervention, Package Choice–Gender, and Package Choice–Intervention, Fisher’s test of independence was used, as the condition of at least five entries in every cell of a chi-square test was not fulfilled.

The descriptive and inferential analyses were carried out using R version 4.3.1, Microsoft Excel, and Google Sheets.

3. Results

3.1. Participant Profile

3.1.1. Sampling

In this exploratory study, we recruited 22 students from the campus and randomly assigned them to two groups: an intervention group of 11 students who received a warning message, and a control group, also comprising 11 students. The decision to use a relatively small sample size was primarily driven by the study’s exploratory nature, aiming to test initial hypotheses and collect preliminary data within the context of Virtual Reality (VR) technology. Additionally, the inherent constraints of VR environments, particularly regarding participant management and data collection, played a significant role in determining the sample size.

3.1.2. Demographics

The average participant age was 23.4 years (with a standard deviation of 8.9 years), comprising 73% females and 27% males. Among them, 77% were pursuing bachelor’s degrees, 18% were enrolled in master’s programs, and 5% were Ph.D. candidates.

3.1.3. Attitude Measurement

All scales demonstrated satisfactory reliability levels, as shown in Table 1. Shapiro–Wilk tests showed that the PER scale adhered to the assumption of normality ($p = 0.07$) and the PS ($p < 0.001$) and GPI ($p = 0.04$) scales deviated from a normal distribution. Consequently, non-parametric tests were employed for all three scales.

Table 1. Reliability measures of scales.

Scale	Number of Items	Cronbach’s Alpha
Perceived seriousness of environmental behavior (PS)	6	0.76
Perceived environmental responsibility (PER)	5	0.61
Green purchase intention (GPI)	10	0.85

3.2. Influences on Environmental Attitudes

Table 2 presents confidence intervals and p -values from Mann–Whitney tests, comparing (a) gender differences, (b) individuals with varying educational levels, and (c) the intervention and control groups across the three environmental attitude scales. Notably, gender emerged as the sole factor significantly impacting personality traits associated with pro-environmental values, consistently favoring females as being more conscious. Hypothesis 1 was confirmed in part.

Table 2. Differences in attitude scales among subgroups.

	PS		PER		GPI	
	Difference	<i>p</i> -Value	Difference	<i>p</i> -Value	Difference	<i>p</i> -Value
Female–Male	1.2 (0.2–1.9)	0.02 **	1.2 (0.5–1.8)	0.003 ***	1.6 (0.5–2.6)	0.0005 ***
Undergraduate– Postgraduate	0.7 (−1.0–1.6)	0.6	−0.6 (−0.2–1.5)	0.1	0.7 (−1.3–2.7)	0.6
Intervention–Control	0.5 (−0.1–1.2)	0.2	0.3 (−0.3–1.0)	0.3	0.0 (−0.9–0.9)	0.8

Note: 95% confidence interval given in parentheses. **, significant at 95% confidence level; ***, significant at 99% confidence level.

3.3. Attitudes Scales and Consumption Choices

The relationship between pro-environmental dimensions as measured by the three scales and the consumption choices in the trial are displayed in Table 3.

Table 3. (a). Attitude scales and meal choice. (b). Attitude scales and choice of packaging.

(a)				
	Vegetarian	Meat/Fish	Difference	
	Value	Value	95% CI	<i>p</i> Value
PS	6.8	6.3	−0.1–1.1	0.08 *
PER	6.5	5.9	−0.1–1.5	0.06 *
GPI	6.0	5.0	0.1–1.9	0.05 **
(b)				
	Recyclable	Non-recyclable	Difference	
	Value	Value	95% CI	<i>p</i> Value
PS	6.5	6.1	−0.6–1.4	0.24
PER	6.2	5.5	−0.5–1.8	0.11
GPI	5.5	4.4	0–1.4	0.11

Note: *, significant at 90% confidence level; **, significant at 95% confidence level.

H2 was confirmed for the choice of meal, where those picking the green meal also reported as more green in their values and purchase intentions. There was no similar pattern between packaging choices and environmental attitudes.

3.4. Intervention Message, Packaging, and Choice of Meal

The packaging preference and meal choice, considered in terms of intervention vs. control, are summarized in Table 4.

Table 4. (a). Intervention and choice of meal. (b). Intervention and packaging.

(a)		
	Intervention	Control
	Value	Value
Vegetarian (%)	45	0
Meat/Fish (%)	55	100
(b)		
	Intervention	Control
	Value	Value
Recyclable (%)	82	73
Non-recyclable (%)	18	27

Fisher's test gave a p value of 0.04, thus indicating that the VR message had a significant influence on choice of meal.

Fisher's test gave a p -value of 1, thus indicating that the message did not have a proven influence on packaging selection.

The combined findings from Table 4 offer partial support for Hypothesis 3. The data reveal a significant trend among consumers, indicating that the VR message had a significant influence on choice of meal. However, these results did not indicate a statistically significant result in consumer choices towards items with reduced plastic usage.

Further analysis revealed that neither gender nor education level significantly influenced meal choices or packaging preferences ($p > 0.05$). While females tended to choose vegetarian meals and recyclable packaging more than males, and there were differences between undergraduates and graduates, these variations were not statistically significant according to results from Fisher's test. This suggests that gender and education may not be major factors in environmental choices regarding meals and packaging.

4. Discussion

This study delved into the intricate interplay between pro-environmental attitudes, dietary preferences, and packaging choices within the context of a VR restaurant scenario. The results underscored the significant influence of gender on pro-environmental attitudes, aligning with previous research highlighting women's heightened engagement in sustainable behaviors [16,17]. The potential causative links between gender roles, psychological differences, and perceptions of responsibility necessitate further exploration to comprehend the underlying dynamics. All three hypotheses were fulfilled, but only in part, as the main effects were:

(i) Females being more conscious of environmental consumption, (ii) those choosing plant-based meals having higher values on the green scales, and (iii) the warning message leading to more vegetarian meals being chosen. The investigation, hence, suggested a connection between environmental awareness interventions and positive transformations in attitudes, although these findings did not reach statistical significance. This echoes the principle of "nudging" as a valuable tool to encourage sustainable behaviors [26,27]. However, the primary intended effect of reducing plastic usage by selecting reusable packaging was not observed. The message was more efficient in shifting respondents towards the meal choice without animal proteins.

The link between dietary choices and environmental consciousness has been investigated extensively, with a vegetarian diet frequently associated with lower environmental impact [22]. This study's findings add to this narrative, but the nuanced nature of dietary preferences, influenced by factors beyond environmental concerns, highlights the complexity of causation. With regards to socio-demographics, the gender dimension has been underlined through multiple surveys confirming that females in general are better aligned with environmental health in their attitudes and consumption [17–19]. As far as higher degrees go, research has confirmed two opposing effects; on the one hand, greater knowledge of climate issues spurs more sustainable actions while a higher income also leads to a higher footprint, even more so for the most affluent and highest echelons of social status [34].

In terms of packaging choices, the research did not identify statistically significant relationships between gender, pro-environmental attitudes, and packaging preferences. However, the potential implications of these choices on plastic waste and environmental impact remain paramount. The significance of efforts to reduce single-use plastics and promote eco-friendly alternatives requires sustained attention [29].

Despite its contributions, this study possesses certain limitations. The relatively small sample size and the use of a convenience sample from a single demographic could undermine the generalizability of the results. Furthermore, the potential influence of contextual factors like price and social pressure on participants' choices in the VR scenario is

not fully addressed. Additionally, while the VR approach facilitates control and immersion, the experiential aspect might introduce biases related to personal interpretation.

5. Conclusions

This study ventured into the dynamic relationship between pro-environmental attitudes, dietary choices, and packaging preferences within a VR restaurant scenario. While the results suggested significant correlations between gender and pro-environmental attitudes and a potential connection between adopting vegetarian diets and pro-environmental attitudes, the study also highlighted the nuanced yet complex nature of these relationships. The potential impact of interventions, such as environmental awareness messages, on transforming attitudes towards sustainability was also hinted at, although not statistically proven.

As behavioral interventions like nudging become increasingly common practice, this study's application of VR serves as a steppingstone towards understanding how individuals interact with choice scenarios in the quest for a greener future. It is important to reiterate that factors beyond dietary choices, such as social norms, access to resources, and education level, influence consumers' pro-environmental behavior. Therefore, while dietary choices can be essential in reducing environmental impact, they are not the only factor and should not be viewed in isolation. One's consumption patterns, whether related to diet or materials, may reflect personal values that result from individualistic and societal conditioning. Identifying solid correlations between these factors and dietary choices may be possible, though implying causation may be misleading and merits continued avenues of exploration. Ultimately, the pursuit of sustainable behaviors and a reduction in environmental impact found in this study underscores the monumental need for continued interdisciplinary research, larger-scale studies, and strategic interventions for the food service sector. This task mandates a profound introspection into what truly drives green lifestyles and a rigorous evaluation of multifaceted factors' pivotal roles in shaping attitudes.

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