Journal of Environmental and Agricultural Studies
ISSN: 2710-1401
DOI: 10.32996/jeas
Journal Homepage: www.al-kindipublisher.com/index.php/jeas

JEAS
AL-KINDI CENTER FOR RESEARCH AND DEVELOPMENT

| RESEARCH ARTICLE

Effects of repeated immersive virtual reality exposure on attitudes and intentions to avoid single-use plastics: moderating role of environmental concern

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| ABSTRACT
The aim of this study was to examine whether repeated exposure to an immersive virtual reality experience—as opposed to a single exposure—could reinforce individuals' attitudes and intentions to avoid single-use plastics, incorporating environmental concern as a moderating variable. A laboratory experiment was conducted with 107 students. Participants were exposed to an immersive virtual reality video (vs. non-immersive), and their attitudes and intentions were measured at two distinct points in time: before and after exposure. The study's findings reveal that repeated exposure to immersive virtual reality has a significant effect on participants' attitudes and intentions to avoid single-use plastics, greater than that of a single exposure. Furthermore, it appears that environmental concern positively moderates the relationship between attitude and intention: the more concerned individuals are about the environment, the greater the impact of their attitude on their intention to avoid single-use plastics.

| KEYWORDS
Virtual reality; attitude; intention to avoid single-use plastic; environmental concern

| ARTICLE INFORMATION
ACCEPTED: 01 November 2025 **PUBLISHED:** 15 December 2025 **DOI:** 10.32996/jeas.2025.6.4.5

1. Introduction

Plastic pollution is one of the major challenges facing governments. It is a serious environmental problem that endangers both the planet's inhabitants and the planet itself. Single-use plastic harms ecosystems and wildlife because it takes centuries to disintegrate and can remain in the environment for decades (Uehara *et al.,* 2023). Because of its durability and resistance to degradation, plastic has become an environmental risk (Ali *et al.,* 2022). Inappropriate disposal of plastic waste leads to littering of various ecosystems and threatens environmental sustainability (Xu *et al.,* 2022). Despite the advantages of plastics in terms of comfort and safety, their single-use nature and inappropriate disposal outweigh these benefits. Due to the harmful effects of plastics on the environment and human health, the scientific community, governments, the media and the general public are paying increasing attention to environmental management issues (Ali *et al.,* 2022). For society to function properly, plastic must be used and disposed of correctly (Dilkes-Hoffman *et al.,* 2019). All over the world, people use and consume single-use plastic products such as bags, bottles, straws, etc. (Li *et al.,* 2021). However, these items are at the root of major environmental and societal problems, such as plastic pollution, greenhouse gas emissions, waste management problems, etc. Analyzing and changing public attitudes towards plastic use and avoidance (Cavaliere *et al.,* 2020) is essential to solving these problems. Nevertheless, one of the most important strategies for avoiding plastic use and reducing its waste is to develop pro-environmental and plastic-avoidance behavior among the public. In this context, virtual reality (VR) has emerged as a particularly effective persuasive technology for promoting specific behaviors. Studies have shown that immersive VR can persuade

individuals to adopt certain behaviors (Chirico *et al.,* 2020). As such, it has been successfully used to raise awareness and change attitudes on a variety of environmental issues (Thoma *et al.,* 2023; Nouri *et al.,* 2025).

Although VR is increasingly seen as a promising tool for fostering a deeper appreciation of environmental challenges and supporting sustainable behavior (Chirico *et al.,* 2020; Thoma *et al.,* 2023), the effects of repeated exposure to this technology remain largely understudied (Frechette *et al.,* 2023), particularly in the context of single-use plastic consumption and management. Indeed, to the best of our knowledge, the majority of existing studies have been conducted in the form of a single intervention, as opposed to approaches involving repeated exposures. Single exposures to VR often confused participants due to their lack of familiarity with VR technology and the novelty effect (Dhimolea *et al.,* 2022). Thus, several researchers indicate that acceptance and use of immersive VR may be significantly reduced due to undesirable side effects caused by cybersickness (Breves and Dodel, 2021). Although several previous studies in various fields have examined the effect of repeated exposure to VR (Adhanom *et al.,* 2022; Palmisano and Constable, 2022), to the best of our knowledge, the majority of them have focused only on its effect on the mitigation of cybersickness, without investigating its impact on individuals' attitude and behavioral intention. In addition, some authors (Dilkes-Hoffman *et al.,* 2019; Daffin and Lane, 2021) have found that individuals with high environmental concern are more inclined to modify their behavior. Thus, environmental concern may determine the likelihood of implementing concrete behaviors aimed at reducing plastic use. These limitations highlight the need to study the impact of repeated immersive VR exposures on attitude and behavioral intention to avoid single-use plastic. Indeed, understanding and overcoming these challenges is essential to designing more robust and effective interventions, capable of maximizing the potential of immersive VR as a tool for awareness-raising and sustainable behavior change. Consequently, this study aims to examine the effect of repeated exposure to immersive VR (vs. single exposure) on attitude and behavioral intention to avoid single-use plastic, incorporating environmental concerns as a moderator. This article aims to answer the following research questions:

- Does repeated exposure to immersive VR increase attitude and behavioral intention to avoid single-use plastic?
- Does environmental concern affect the relationship between attitude and behavioral intention to avoid single-use plastic?

This paper is organized as follows. The first part is devoted to a literature *review*, in which the relevant theoretical foundations and previous studies on key concepts are addressed, before formulating the research hypotheses. Next, the methodological approach adopted is presented, followed by the results of the study. Finally, the article examines these results in the light of existing work, highlights the theoretical and practical implications of the study, and suggests avenues for future research.

2. Literature review

Recently, VR has emerged as an innovative strategy for raising awareness and transforming attitudes towards environmental issues (Markowitz *et al.,* 2018; Nouri *et al.,* 2025). One of VR's major strengths lies in its ability to create immersive, interactive environments, generating a strong sense of "presence", making experiences emotionally engaging and memorable (Waterworth *et al.,* 2015). This immersion is particularly enhanced by the use of VR headsets, which isolate the user from the outside world and cover a large portion of their field of vision, creating an immersive experience in 3D environments (Thoma *et al.,* 2023). Immersive VR has demonstrated its potential for modifying pro-environmental behaviors (Thoma *et al.,* 2023). For example, immersive scenarios showing the direct impact of plastic waste on marine wildlife or natural landscapes can build empathy and motivate users to reduce their plastic use (Markowitz and Bailenson, 2021). In addition, it stimulates user interest (Makransky and Mayer, 2022) and improves behavioral responses by fostering positive attitudes towards sustainable solutions (Plechatá *et al.,* 2022).

While traditional media can help explain and illustrate environmental issues, the use of immersive VR could have more powerful psychological effects (Thoma *et al.,* 2023). Indeed, in recent years, research has made considerable progress in using VR to influence opinions, attitudes and behaviors (Slater and Sanchez-Vives, 2016). Although its application in the field of environmental impact is still rather limited (Meijers *et al.,* 2023), studies have explored its potential (Nouri *et al.,* 2025). Immersive VR experiences, usually offered via a head-mounted display (HMD), isolate the user from the outside world and occupy a large part of their field of vision, reinforcing the sense of presence in the virtual world (Thoma *et al.,* 2023). However, HMD use can lead to negative consequences such as cybersickness (Breves and Dodel, 2021). Cybersickness, or VR-induced motion sickness, includes symptoms such as nausea, disorientation and oculomotor discomfort associated with HMD use (Zhao *et al.,* 2022). This phenomenon is a major barrier to effective VR experiences (Adhanom *et al.,* 2022). Several studies have shown that repeated exposure to VR significantly reduces cybersickness (Palmisano and Constable, 2022). For example, exposure to the same VR application on two consecutive days resulted in a decrease in symptoms from the second day (Palmisano and Constable, 2022), with a progressive decrease on subsequent exposures (Howarth and Hodder, 2008). This phenomenon can be explained by the development of tolerance to the stimuli that trigger cybersickness, but also by the gradual learning of adaptive behaviors that make it possible to better manage undesirable effects (Keshavarz *et al.,* 2018). Thus, repeated exposure promotes physiological

habituation, progressively reducing the symptoms of cybersickness and facilitating user engagement in immersive environments (Chirico *et al.,* 2020; Palmisano and Constable, 2022). By reducing the discomfort associated with VR, users can experience a stronger sense of presence in the virtual environment, thereby increasing their receptivity (Makransky and Petersen, 2021). When these immersive environments highlight the negative impacts of single-use plastics, such as their accumulation in the oceans or their effect on wildlife, they can evoke strong emotions and encourage changes in behavior (Markowitz and Bailenson, 2021). Based on the literature developed above, it is possible to hypothesize that repeated exposure to VR could reinforce attitudes and behavioral intentions to avoid single-use plastic. Accordingly, hypotheses H1 and H2 are as follows:

H1: Repeated exposure to a 360° immersive video increases participants' attitude towards single-use plastic avoidance more than a single exposure.

H2: Repeated exposure to a 360° immersive video increases participants' behavioral intention to avoid single-use plastic more than a single exposure.

Numerous studies have highlighted the crucial role of attitude in shaping behavioral intentions, particularly when it comes to adopting behaviors aimed at reducing single-use plastic consumption. According to prevailing psychological models of behavior, a favorable attitude towards a given behavior increases the likelihood that an individual will express the intention to perform it (Chirico *et al.,* 2020). In line with this logic, several empirical studies have confirmed that positive attitudes towards environmentally friendly behaviors significantly predict the intention to reduce plastic use. For example, Chang and Chou (2018) showed that consumers with a favorable attitude towards waste reduction are more likely to bring their own bags when shopping. Similarly, Ting *et al.* (2020) observed that positive attitudes towards reduction, reuse and recycling translate into stronger intentions to put these behaviors into practice in the context of plastic management. Other studies highlight that attitude plays a decisive role in adopting behaviors aimed at reducing plastic waste, whether it be refusing unnecessary plastic products or favoring more sustainable alternatives (Dilkes-Hoffman *et al.,* 2019). Furthermore, several studies have shown that a favorable attitude towards reducing plastic bag consumption can lead to significant behavioral changes (Vimal *et al.,* 2020). However, the predictive effectiveness of attitude does not depend only on its positive or negative valence: it also depends on its degree of consistency with other personal beliefs, values and concerns (Gu *et al.,* 2023).

It is in this context that environmental concerns play a central role. When individuals are highly concerned about the ecological consequences of plastic pollution, they are more likely to translate their attitudes into effective behavior. Indeed, Linh *et al.* (2019) showed that intentions to reduce plastic waste are strongly influenced by consumers' environmental awareness. Similarly, Hao *et al.* (2019) found that Chinese consumers willing to pay more for biodegradable packaging are also those who express high concern about plastic pollution. This environmental concern therefore acts as a catalyst: it reinforces the internal consistency between positive attitude and desired behavior, which increases the likelihood of action. Daffin and Lane (2021) illustrate this idea by showing that a person who is in favor of recycling and simultaneously concerned about the environment will recycle more regularly than a person with the same attitude but less environmental concern. Conversely, when environmental concerns are low, particularly due to cost or sustainability issues, individuals are less inclined to change their behavior, even when they have a generally positive attitude towards reducing plastic use (Dilkes-Hoffman *et al.,* 2019). This highlights the importance of considering environmental concern as a variable in its own right, capable of amplifying or mitigating the translation of an attitude into intention.
Thus, the literature suggests that environmental concern related to plastic pollution could play an essential role in the formation of behavioral intentions. The higher the level of concern, the stronger the link between attitude and intention; conversely, when concern is low, even a favorable attitude may not translate into concrete intention. From this perspective, the hypothesis is as follows:

H3: Plastic-related environmental concern moderates the positive effect of attitude on behavioral intention to avoid single-use plastic.

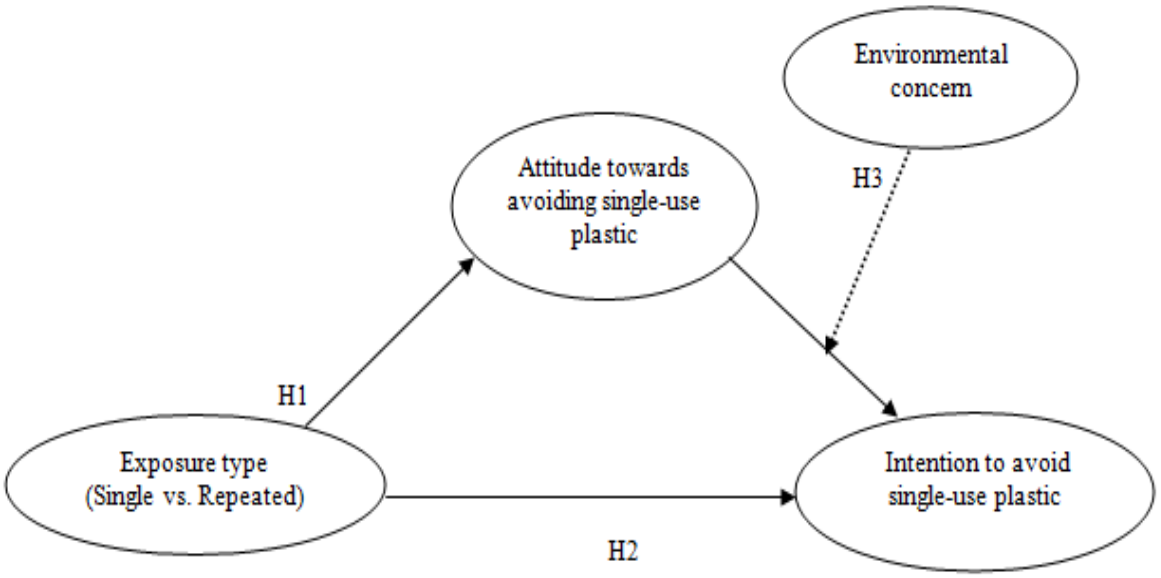

Figure1: Conceptual Model

3. Methodology

3.1 Design and procedure

In order to study the impact of repeated exposure to immersive VR on attitudes towards plastic use and behavioral intention to avoid single-use plastic, a 360° immersive video lasting 5 minutes and 12 seconds was specially designed for this research. This video highlights not only the harmful effects of plastic on the environment, but also the sustainable alternatives and their benefits. It takes viewers to the heart of preserved natural landscapes, such as heavenly beaches, lush green forests and clear rivers. Progressively, these settings are invaded by plastic waste, vividly illustrating the extent of the problem. Poignant scenes show the direct consequences of this pollution: marine animals trapped in abandoned fishing nets, birds ingesting fragments of plastic, rivers clogged with discarded packaging. The impact on human health is also addressed, notably through the contamination of water resources and the presence of microplastics in the food chain. Beyond the alarming facts, the video highlights concrete alternatives for reducing plastic pollution and their benefits. Viewers discover various sustainable solutions, such as the use of reusable bags, stainless steel water bottles and biodegradable packaging. As these alternatives are presented, the virtual environment evolves, offering an instant visualization of their positive impact: plastic waste gradually disappears, water regains its clarity and wildlife is preserved. This immersive approach allows people to directly experience the effects of their choices in a simulated environment, increasing their awareness and engagement towards more sustainable behaviors. By highlighting the tangible benefits of avoiding single-use plastic, the video aims to encourage behavioral change in favor of more environmentally-friendly solutions.

To test research hypotheses, a laboratory experiment was conducted by manipulating the frequency of exposure to 360° immersive video. The study comprises two experimental conditions: single exposure and repeated exposure. Participants were students at a Tunisian university. Those who agreed to take part were given detailed instructions on how the experiment would be conducted, including the time and place of the laboratory sessions. Before starting the experiment, they gave their informed consent, guaranteeing their understanding of the study's objectives and their agreement to take part. In the single-exposure condition, participants went to the laboratory just once to watch the immersive video. In contrast, in the repeated exposure condition, participants viewed the immersive video four times, one session per day for four consecutive days. Each session after the first was held exactly 24 hours after the previous one. The choice of a protocol of repeated exposures on successive days is based on several considerations. Firstly, this approach is in line with the recommendations of Doty *et al.* (2024), who highlight the importance of short-term repetition to reinforce the impact of messages. Secondly, it facilitates data collection by reducing the logistical constraints associated with longer exposure periods. Finally, it helps to improve the presence rate of participants, by limiting the risk of dropping out. On arrival at the laboratory, all participants, independently of their experimental condition, first completed a pre-experimental assessment of their attitude and their behavioral intention to avoid single-use plastic. They were then randomly assigned to one of two experimental conditions (single or repeated) and equipped with a VR headset (Samsung Gear VR) to view the immersive video. After viewing the video, participants in the single exposure condition

immediately completed a questionnaire measuring their level of cybersickness, their attitude, their behavioral intention to avoid single-use plastic and their plastic-related environmental concern. In contrast, for participants in the repeated exposure condition, these assessments were only carried out after the fourth and final session.

3.2 Measures

In order to measure the variables, this study relied on scales borrowed from the literature and adapted to the specific context of this research. *Cybersickness* was measured using 4 items developed by Bracken (2005) that assessed the degree of nausea experienced by participants. For the measurement of *attitude towards single-use plastic avoidance*, the scale developed by Gu et al. (2023) was used. It is a seven-point Likert scale, consisting of 3 items and a single dimension. Similarly, *behavioral intention to avoid single-use plastic* was measured using a seven-point Likert scale, composed of 3 items developed by Gu *et al.* (2023). *Plastic-related environmental concern* was measured using 3 items developed by Gu *et al.* (2023). To check the reliability and validity of all the measurement scales, exploratory and confirmatory factor analyses were carried out. The results obtained (Table 1) enabled us to conclude that all the scales were reliable and valid.

Table 1: Results of exploratory and confirmatory factorial analyses

Variables	Cronbach alpha	Composite reliability	AVE
Attitude towards avoiding single-use plastic	0.889	0.902	0.754
Plastic Avoidance Intentions	0.808	0.810	0.586
Plastic-Related Environmental Concern	0.881	0.882	0.714
Cybersickness	0.914	0.937	0.788

4. Results and discussion

4.1 Participants

Participants were recruited via advertisements on university digital platforms and social networks. Before taking part in the study, each individual was given detailed information about the conduct of the experiment and signed an informed consent form. The aim was to ensure a clear understanding of the requirements of the study and to ensure the transparency of the process.
A total of 108 students agreed to take part in the study in exchange for financial compensation. However, one participant assigned to the repeated exposure condition did not complete the required four sessions, resulting in his exclusion from the analyses. Consequently, the final sample analyzed comprises 107 participants who completed the entire experimental protocol. The gender breakdown showed a predominance of women, with 58.9% compared with 41.1% men. The average age of the participants was 23.14, with a range of ages from 20 to 35.

4.2 Hypotheses testing

Before testing the hypotheses, the level of cybersickness experienced by the participants was assessed to see if it could influence the results. The results showed a significant difference between the two experimental conditions: participants exposed several times to the 360° immersive video reported a lower level of cybersickness than those who had viewed it only once ($M_{Single\ exposure}$ = 5.00 vs. $M_{Repeated\ exposure}$ = 2.31, t= 10.777, p< .01). This difference justifies the inclusion of cybersickness as a covariate in the statistical analyses, in order to neutralize its potential influence.

To evaluate the first two hypotheses (H1 and H2), two mixed ANOVAs were conducted. The type of exposure (single vs. repeated, coded 0 and 1 respectively) was included as an inter-subject factor, while the measurement time (before vs. after exposure) was considered an intra-subject factor. The results of the first mixed-model ANOVA analysis (Table 2) showed the presence of a significant effect of exposure type (single vs. repeated) on attitude. Participants repeatedly exposed to the video reported significantly higher attitude towards single-use plastic avoidance scores than those exposed only once ($M_{Repeated\ exposure}$ = 3.97 vs. $M_{Single\ exposure}$ = 3.04; F = 29.897, p <.01, Eta² =.222). Similarly, the main effect of time proved to be significant: attitude towards single-use plastic avoidance was higher after exposure to immersive video than before ($M_{After\ exposure}$ = 4.13 vs. $M_{Before\ exposure}$ = 2.87; F = 62.275, p <.01, Eta² =.372). Furthermore, the results revealed the existence of a significant interaction between type of exposure and time on attitude (F = 36.853, p <.01, Eta² =.260). Two ANCOVA analyses were performed to investigate this interaction, in which cybersickness was included as a covariate. The results (Table 2) showed the presence of a significant difference in participants' attitude before and after repeated exposure to the video (F = 99.388, p <.01), where participants reported higher levels of attitude after repeated exposure to the video ($M_{After\ repeated\ exposure}$ = 5.08) than before repeated exposure ($M_{Before\ repeated\ exposure}$ = 2.85), while no significant difference

was found in participants' attitude before and after single exposure to the video (F = 2.126, p >.05). Therefore, attitude towards single-use plastic avoidance increased significantly only after repeated exposure to immersive video, but not for the single exposure. Hence, hypothesis *H1* is accepted. Cybersickness has a significant effect only in the single exposure condition (p <.01).

The results of the second mixed-model ANOVA analysis (Table 2) showed the presence of a significant effect of exposure type. Participants repeatedly exposed to the immersive video showed significantly higher behavioral intention to avoid single-use plastic than those exposed only once ($M_{Repeated\ exposure}$ = 3.76 vs. $M_{Single\ exposure}$ = 2.93; F = 21.858, p <.01, Eta²= .172). Similarly, the main effect of time was significant (before vs. after), with behavioral intention to avoid single-use plastic was higher after exposure to immersive video than before ($M_{After\ exposure}$ = 3.85 vs. $M_{Before\ exposure}$ = 2.83; F = 40.400, p <.01, Eta²= .278). Furthermore, the results revealed a significant interaction between exposure type and time on behavioral intention to avoid single-use plastic (F = 16.699, p <.01, Eta² =.137). Two ANCOVA analyses were performed to investigate this interaction, in which cybersickness was included as a covariate. The results (Table 2) showed the presence of a significant difference in participants' intention before and after repeated exposure to immersive video (F = 41.821, p<.01), where participants reported higher levels of behavioral intention to avoid single-use plastic after repeated exposure to immersive video ($M_{After\ repeated\ exposure}$ = 4.60) than before repeated exposure ($M_{Before\ repeated\ exposure}$ =2.92), while no significant difference was found in participants' behavioral intention to avoid single-use plastic before and after single exposure to immersive video (F = 2.272, p >.05). Therefore, behavioral intention to avoid single-use plastic increased significantly only after repeated exposure to immersive video, but not for the single exposure. Hence, hypothesis *H2* is accepted. Cybersickness has a significant effect only in the single exposure condition (p <.01).

Table 2: Result of Repeated-measures ANOVA and ANCOVA by group

Repeated-measures ANOVA										
			Dependent variables							
			Attitude towards single-use plastic avoidance				**Intention to avoid single-use plastic**			
			M	F	p	Eta²	M	F	p	Eta²
Exposure type	Single N=55)		3.04	29.897	.000	.222	2.93	21.858	.000	.172
	Repeated (N=52)		3.97				3.76			
Time	Before		2.87	62.275	.000	.372	2.83	40.400	.000	.278
	After		4.13				3.85			
Type of exposure * Time	Before	Single	2.89	36.853	.000	.260	2.75	16.699	.000	.137
		Repeated	2.85				2.92			
	After	Single	3.18				3.11			
		Repeated	5.08				4.60			

ANCOVA results by group							
		Attitude towards single-use plastic avoidance			**Intention to avoid single-use plastic**		
Exposure	**Time**	**M**	**F**	**p**	**M**	**F**	**p**
Single (n=55)	Before	2.89	2.126	.148	2.75	2.272	.135
	Repeated	3.18			3.11		
Repeated (n=52)	Before	2.85	99.388	.000	2.92	41.821	.000
	Repeated	5.08			4.60		

To test hypothesis H3, a moderated mediation analysis was performed using the Macro PROCESS method, model 14, with 5000 *bootstraps*. The results obtained (Figure 2) revealed that exposure type significantly and positively influenced both attitude (β=.89; p< .01) and behavioral intention to avoid single-use plastic (β= .23; p< .05). Furthermore, the results showed that attitude, in turn, significantly and positively influenced behavioral intention to avoid single-use plastic (β= .49, p< .01) and that plastic-related environmental concern significantly and positively moderated this relationship (M*W= .34; p< .05). Consequently, hypothesis *H3* was accepted. These results indicate that, for individuals who are particularly concerned about the environmental issues associated with plastic, a favorable attitude towards avoiding single-use plastic leads to a stronger intention to modify their behavior accordingly.

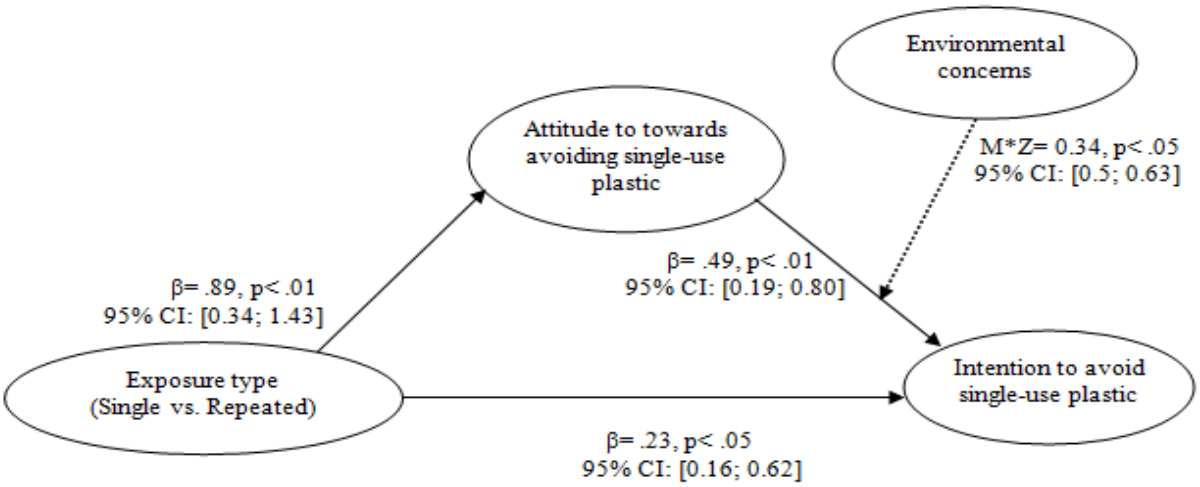

Figure 2: Moderated mediation analysis

4.3 Discussion

The results of this study show that repeated exposure to immersive VR led to a significant reduction in the degree of cybersickness and further improved participants' attitudes as well as their behavioral intention to avoid single-use plastic. These results are consistent with previous research on repeated exposure to immersive VR and its effects. For example, several studies have demonstrated that repeated exposure to immersive environments reduces cybersickness, facilitating deeper immersion and increased engagement among participants (Howarth and Hodder, 2008). Furthermore, these results concur with those of Makransky and Petersen (2021), who suggest that reduced cybersickness leads to a stronger sense of presence, promoting better absorption of virtual content, as well as those of Markowitz and Bailenson (2021), who found that immersive environments can elicit strong emotions and encourage changes in behavior. The results of this study also showed that environmental concern about plastic moderates the positive effect of attitude on behavioral intention to avoid single-use plastic, which is consistent with previous work. As a result, Linh *et al.* (2019) found that consumers' behavioral intentions to reduce plastic waste are strongly influenced by their level of plastic-related environmental concern. Similarly, Hao *et al.* (2019) demonstrated that consumers' willingness to pay for sustainable alternatives, such as biodegradable packaging, is linked to their concern about plastic pollution. This is also supported by Daffin and Lane (2021), who observed that a pro-recycling attitude, combined with a strong valuation of environmental protection, increases the likelihood of recycling.

5. Conclusion

This study makes an important contribution to the literature on immersive VR and its application in pro-environmental behaviors. Its originality lies in investigating the effect of repeated exposure to immersive VR on the attitude and behavioral intention to avoid single-use plastic, a subject that is still largely understudied. Unlike the majority of existing research, which is limited to single interventions, this study demonstrated that repetition of the immersive experience can attenuate the effect of cybersickness and reinforce the attitude and behavioural intention to avoid single-use plastic. In addition, by including environmental concern as a moderating variable, this research provided a more detailed understanding of the psychological mechanisms that encourage the adoption of sustainable plastic management behaviours. Furthermore, the study reveals that environmental concern moderates the relationship between attitude and behavioral intention, suggesting that people concerned about environmental issues respond more favorably to VR interventions, enriching our understanding of the dynamics between psychological factors and pro-environmental behaviors. This study also suggests a number of managerial contributions. Firstly, it highlights the importance of repeated exposure to immersive VR in significantly reducing the degree of cybersickness. This observation is crucial for organizations wishing to integrate this technology into their strategies, as it demonstrates that repetition can enhance the user experience, thereby reducing barriers to engagement. Managers can therefore plan immersive campaigns over several sessions, to maximize effectiveness and minimize the negative side-effects associated with HMD headset use. Secondly, the results show that repeated exposure improves not only attitudes towards single-use plastic avoidance, but also participants' behavioral intentions. This underlines the importance of designing immersive campaigns focused on specific environmental issues, such as plastic waste reduction. For example, companies and the NGO sector can leverage VR to create immersive simulations that highlight the environmental consequences of single-use plastic, encouraging individuals to adopt more sustainable practices, such as the use of reusable materials. Furthermore, the study reveals that environmental concern moderates the relationship between attitude and behavioral intention to avoid plastic. These findings encourage managers to

segment their target audiences according to their level of environmental concern. For individuals concerned about environmental issues, immersive interventions could be designed to reinforce their pro-environmental beliefs and behaviors. On the other hand, for less concerned individuals, prior education or awareness-raising strategies may be required to maximize the impact of immersive VR experiences. Finally, this study demonstrates the potential of immersive VR as a strategic tool for innovation in environmental awareness. Companies, educational institutions and NGOs should consider investing in this technology to design repeated immersive experiences, not only to inform, but also to encourage concrete action. By integrating immersive initiatives into their strategies, organizations can not only reach a wide audience, but also foster sustainable behavioral changes in terms of consumption and environmentally-friendly practices.

There are some limitations to this study that provide avenues for future research. Firstly, although the selection of students seems appropriate for the study, it limits the generalizability of the results to the general population. Future research with a larger, more diverse sample is imperative to broaden the scope of this study. In addition, the sample was drawn from a single country, Tunisia, which may limit the generalizability of results to other cultures or populations. Consequently, it would be interesting to examine the proposed model in other countries or populations.

Funding: This research received no external funding.

Conflicts of Interest: The authors declare no conflict of interest.

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