國立臺灣大學生物資源暨農學院

生物產業傳播暨發展學系

博士論文

Department of Bio-Industry Communication and Development

College of Bio-Resources & Agriculture

National Taiwan University

Doctoral Dissertation

虛擬實境中的同理心與臨場感對肉類消費意願改變的研究

How Empathy and Presence in Virtual Reality Affect Willingness to Reduce Meat Consumption

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中華民國 114 年 4 月

April, 2025

doi:10.6342/NTU202504615

國立臺灣大學博士學位論文
口試委員會審定書

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本論文係 侯佳宜（D00630002）在國立臺灣大學生物產業傳播暨發展學系完成之博士學位論文，於民國 114 年 4 月 12 日承下列考試委員審查通過及口試及格，特此證明

口試委員：

（指導教授）

系 主 任：　　　　（簽名）

doi:10.6342/NTU202504615

ACKNOWLEDGEMENT

我終於完成博士學位了。自 2005 年啟程，漫長歲月中，承蒙多人扶持。

指導老師蕭崑杉教授，即便退休仍細心督勉；另一位指導老師，王俊豪教授的建議與論文投稿、發表流程上多所襄助，促使本研究得以順利刊登於期刊。口試委員黃馨慧、蔡必焜、方珍玲、張春炎諸位教授的專業意見，令我獲益良多。

感謝生傳所所長陳玉華教授與黃麗君教授在我進入博士班以後，不斷給我打氣。也謝謝邱玉蟬教授對我在質化研究上的精進。謝雨生教授對我的鼓勵與量化研究上指導與啟發，刻骨銘心，祈願謝教授一路好走。臺大社會系孫中興教授多年暢談提攜，亦師亦友情誼難得。臺灣大學新聞所張錦華、林麗雲兩位教授的鼓勵與在論述分析法的討論，使我得以拓展研究專長。感激碩士論文指導老師、政大退休教授鄭自隆與師母，自我進入臺大新聞所以來一路相伴。大師兄莊伯仲教授的提點，還有政治大學林芝璇教授的關心與支持，銘感於心。也謝謝金光教授 20 幾年來的陪伴，一直是我學術上的心靈導師。

臺大心理所鄭澈博士在統計觀念與分析上的教導與討論，讓我受益匪淺。亦謝謝妙妙、前校、鏡平還有玉英姐於生命旅途中的相伴與應援。感謝生傳系辦**宇誠**的細心與耐心，協助各項行政。

也將此論文謹獻給在天上的小天使，臺大新聞所直屬學姊欣怡。說好拿到博士學位以後要一起合照，妳卻先離開了...願妳看見這份心意。

最深的謝意留給我最摯愛的母親—嘉義縣立民雄國中退休國文教師張素雲女士。自我年幼，母親獨力承擔養育與栽培，是我一生最大的靠山。寫論文前幾年，母親不幸罹患失智症。幸運的是，母親彷彿變成無憂的孩子。我日日哄著這位「小朋友」，一邊陪她看老歌演唱會、逗她開心跟她撒嬌，一邊寫博士論文；感念上天賜予我們如此深厚的緣分。由衷謝謝加入照護行列的印尼妹妹希拉(Tri)，妹妹善良體貼，視母親如自己阿嬤般對待，讓我得以專心完成研究。

제 삶에서 우연히 만나게 된 그대에게 감사드립니다. 끊임없는 자기 도전과 정진이 저를 더 나은 사람으로 성장하게 해 주었습니다.

doi:10.6342/NTU202504615

摘要

為因應紅肉攝取過量所帶來的健康挑戰，本研究聚焦於牛肉消費，探討在虛擬實境（VR）情境中，同理心如何影響飲食態度與行為。借助 VR 所營造的高度沉浸感與感官吸引力，本研究意在探索同理心與臨場感等心理機制是否能促進人們減少牛肉攝取的意圖。研究採用實驗設計，招募 142 位參與者，分析性別、年齡、同理心水準與參與程度等變項對飲食態度的影響。

結果顯示，性別與年齡對同理心、臨場感及飲食態度與行為變化皆無顯著影響。回歸分析發現，同理心對反牛肉飲食態度具邊際顯著的預測力（$p = 0.055$），而性別（$p = 0.358$）與年齡（$p = 0.142$）則不具統計顯著性。此外，這些變項對未來牛肉消費傾向與對牛隻痛苦的態度改變亦未產生顯著解釋力。

研究進一步指出，較高同理心水準可增強參與者在 VR 中的臨場感體驗，進而影響其飲食態度。具備較高同理心的受試者回報更高的臨場感，並表現出降低牛肉攝取的意願。此結果強化了 VR 作為促進情感參與的干預工具之潛力，對於鼓勵健康飲食行為與回應紅肉過度攝取所造成的健康疑慮具有實際意義。

關鍵詞：同理心、肉類消費、臨場感、虛擬實境

doi:10.6342/NTU202504615

ABSTRACT

This study explores the role of empathy in Virtual Reality (VR) environments in influencing dietary willingness and behaviors, with a particular focus on beef consumption. By leveraging VR's immersive and interactive features, the research examines how psychological mechanisms such as empathy and presence shape individuals' intentions to reduce beef intake. An experimental design was employed, involving 142 participants from Taiwan, to test the effects of demographic factors (gender, age), individual differences in empathy, and levels of engagement on changes in dietary behaviors.

The results indicate that gender and age did not significantly affect empathy, presence, or changes in dietary willingness. However, regression analysis showed a marginally significant effect of empathy on the willingness to reduce beef consumption, while other demographic variables were not significant predictors. Additionally, the predictors failed to explain significant changes in future beef consumption willingness and concern for the suffering of cows.

Additional examination demonstrated that compassion markedly strengthens individuals' perception of immersion in virtual reality settings, consequently decreasing their inclination to eat beef. These results indicate that VR technology can function as a potent means of enhancing emotional involvement, encouraging nutritious dietary choices, and reducing health hazards linked to excessive red meat intake.

Beyond the health implications, this research emphasizes the prospect of VR in advancing public health and sustainability initiatives. By encouraging dietary changes, VR interventions can help reduce the health risks of red meat consumption while also addressing the environmental impact of livestock production. The study provides practical insights into designing VR-based behavioral interventions, highlighting

doi:10.6342/NTU202504615

empathy as a fundamental factor and laying the foundation for future research on how VR can influence health-related behavior change.

Keywords: empathy, meat consumption, presence, virtual reality

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CHAPTER ONE

INTRODUCTION

1.1. Background

Red meat, particularly beef, mutton, and pork, acts as an abundant supplier of essential nutrients (McAfee et al., 2010), making it a fundamental component of numerous diets across the globe. However, scientific research emphasizes the possible medical risks related to excessive intake of beef and other animal meats. Research has suggested that high intake of red meat is linked to a greater vulnerabilities of acquiring multiple forms of malignancies, including pancreatic, colorectal, and esophageal conditions. (Alisson-Silva et al., 2016; Domingo & Nadal, 2017; Micha et al., 2010).These health concerns stem from multiple factors, including the presence of heme iron, which can trigger oxidative stress, and the production of harmful chemicals. Moreover, overconsumption of red meat has been associated with metabolic disorders and cardiovascular conditions, such as hypertension and excess weight (Swinburn et al., 2011).

The global economic cost of red meat–related health conditions was projected to reach $285 billion in 2020, constituting roughly 0.3% of worldwide healthcare spending (Springmann et al., 2018).This financial impact underscores the need for public health initiatives to encourage dietary changes, such as reducing red meat intake and adopting more plant-based diets. Such measures not only aim to mitigate health risks but also align with sustainability goals.

The annually published *Food Supply and Demand Annual Report* serves as a vital indicator of the nation's agricultural trends. According to the latest 2023 report, Taiwan's consumption of staple grains, including rice and wheat, has significantly declined. Annual per capita rice consumption has dropped to a record low of 42.1 kilograms, while flour consumption has decreased to 36.2 kilograms, a 5.4% reduction

doi:10.6342/NTU202504615

from the previous year[1]. As grain consumption continues to fall, meat demand has steadily risen. In 2023, per capita meat consumption reached 87.2 kilograms, surpassing the consumption of staple grains. Notably, beef consumption has shown a consistent upward trend in recent years, reaching a record high of 7.6 kilograms per capita in 2023[2].

The public health Implications of red meat consumption are substantial. A survey conducted by the National Animal Industry Foundation (NAIF, 中央畜產會) revealed that between 2013 and 2021, beef consumption in Taiwan increased by an impressive 48%[3].

According to Table 1, beef production has shown a steady increase from 2014 to 2023. In 2014, the production volume was 6,874 metric tons, rising to 8,312 metric tons by 2023, indicating a stable upward trend. On average, beef production grew by approximately 2%-3% annually, reflecting either a sustained increase in demand for beef or advancements in production techniques. Notably, beef production reached a relative peak between 2021 and 2023, with 8,272 metric tons produced in 2022 and 8,312 metric tons in 2023, showcasing stable production at relatively high levels during this period.

[1] https://www.newsmarket.com.tw/blog/212624/?utm_source=chatgpt.com

[2] 孫維揚，林怡均（2024 年 10 月 15 日）。2023 糧食年報 02：每人肉食 87.2 公斤，超越主食成餐桌冠軍，飲品刺激牛乳需求大增。*上下游新聞*。取自 https://www.newsmarket.com.tw

[3] https://www.gvm.com.tw/article/94070?utm_source=chatgpt.com

doi:10.6342/NTU202504615

國內肉類生產 (2014-2023)

單位：公噸

年份	豬肉	牛肉	羊肉及山羊肉	家禽（雞肉）	家禽（鴨肉）	家禽（鵝肉）	家禽（火雞肉）	家禽（其他）	其他
2014	847,200	6,874	1,972	543,161	85,225	22,474	3,357	-	-
2015	864,772	6,875	1,960	533,073	79,989	5,603	3,116	-	-
2016	859,292	6,818	1,859	565,486	82,830	6,306	2,915	-	-
2017	842,707	7,027	1,861	555,323	86,127	9,656	2,927	-	-
2018	860,616	7,059	1,743	597,315	84,540	11,156	2,817	-	-
2019	851,334	7,351	1,877	631,769	87,488	12,091	2,535	-	-
2020	876,265	7,590	1,899	656,930	82,157	15,508	3,068	7	-
2021	856,787	7,743	1,425	684,423	78,870	14,756	2,736	10	-
2022	839,922	8,272	1,387	680,718	83,731	17,862	2,253	629	-
2023	813,300	8,312	1,160	656,897	77,232	15,806	1,718	13	-

Table 1. *Domestic Meat Production 2014-2023*. Source: 糧食供需年報[4]

Although numerous public health campaigns promote reducing red meat consumption and increasing vegetable intake, these initiatives have seen only modest success. In many cultures, red meat continues to be a dietary mainstay, reinforced by deep-rooted traditions, sensory appeal, and perceptions of its nutritional benefits. One reason for the limited impact of these efforts is that most people have no direct exposure to the processes involved in raising and processing animals for meat, such as those occurring on farms and in slaughterhouses (Herrewijn et al., 2021; Kunst & Haugestad, 2018). Without firsthand experience, the implications of meat consumption remain abstract, making it challenging for individuals to develop strong emotional or ethical connections.

Virtual reality (VR) offers a potential solution to this problem by providing immersive, first-person experiences that can make distant or unfamiliar realities—like animal farming—more immediate and emotionally resonant. By visually and

[4] file:///Users/chiaihou/Downloads/BB_B04-1-01-B04-1-09_112%20(1).pdf

doi:10.6342/NTU202504615

experientially bridging the empathy gap, VR may enhance people's understanding of the ethical, environmental, and health-related implications of their dietary choices. As such, VR holds promise as a persuasive tool for motivating behavioral change, particularly when it leverages psychological mechanisms such as empathy and presence.

Instead, consumers primarily interact with neatly packaged meat products available in markets, creating a psychological and emotional disconnect from the realities of animal farming. This lack of awareness often prevents consumers from recognizing the moral, ecological, and wellness-related consequences of consuming animal products (Camilleri et al., 2020).

The principle of "seeing Is believing" underscores the Importance of direct experience in shaping willingness and beliefs. According to Chang (2013), firsthand exposure is often perceived as more credible and impactful than indirect information. Ahn (2021) additionally emphasizes that firsthand encounters—where individuals directly observe events or situations—have a greater impact on altering willingness compared to secondhand experiences gained through indirect sources (Hamilton & Thompson, 2007). Direct experiences not only form stronger willingness but also foster greater confidence in those willingness, leading to more consistent behavioral changes (Ahn, 2021). Fazio and Zanna's (1981) study indicates that persuasive strategies designed to mirror the qualities of direct experiences—such as richness in detail and user engagement—tend to be more successful in influencing attitudes and modifying behaviors (Herrera et al., 2018; Ahn, 2021).

Virtual reality (VR) stands out as an innovative solution to overcome the shortcomings of conventional health promotion strategies. Unlike traditional media like television or books, VR enhances engagement by offering a greater sense of presence and interactivity (Ahn, 2021). By immersing users in realistic simulations, it allows

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individuals to directly experience the realities of animal farming, meat processing, and environmental consequences, enabling them to "witness firsthand" what is often hidden from view. Herrera et al. (2018) found that engaging with a story from a first-person perspective in a VR setting enhances empathy more effectively than reading the same content in written form, highlighting VR's unique ability to create emotional connections.Similarly, Jeon et al. (2024) concluded that VR strengthens empathetic responses by offering immersive and participatory experiences, positioning it as a more engaging substitute for conventional learning or training methods. Although VR has demonstrated potential in influencing dietary willingness and behaviors, much of the existing research has prioritized examining outcomes rather than the psychological mechanisms driving these changes. Plechatá and colleagues (2022) demonstrated that VR can reduce participants' dietary carbon footprints and enhance their perceived ability to make a difference. Nevertheless, their research overlooked essential psychological components, including empathy and presence, which play a pivotal role in understanding VR's influence on persuasion. In the same vein, studies investigated VR's capacity to promote eating behavior changes but did not explicitly examine the impact of these cognitive factors (Meijers, Song, and Fiore, 2017; Xu et al., 2023; Wan et al., 2022).

The integration of variables like empathy and presence Is crucial for optimizing the design and application of VR interventions. Empathy allows users to emotionally connect with the subject matter, fostering deeper understanding and motivation for change. Presence, on the other hand, enhances the immersive quality of VR experiences, making the virtual environment feel real and impactful. Together, these psychological factors can significantly amplify the effectiveness of VR interventions, bridging the gap between awareness and action. As VR technology progresses, upcoming studies should

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investigate these mechanisms in greater depth, paving the way for more targeted and impactful applications in health promotion and dietary behavior change.

Existing research on the intersection of VR, empathy, presence, and meat consumption willingness is scarce, with only two studies addressing this relationship—and only one offering a comprehensive exploration of these variables. Anderson and colleagues (2017) investigated the influence of virtual environment on individuals' inclination to decrease pork consumption and cultivate greater awareness of animal well-being. Likewise, Herrewijn et al. (2021) analyzed VR's impact on persuasion, revealing that an increased sense of immersion could strengthen empathetic reactions. While numerous studies have found that increased presence tends to boost empathy, which subsequently influences behavioral intentions, the exact nature of this relationship remains unclear. Some researchers suggest that empathy may precede presence, implying that individuals with a higher natural capacity for empathy are prone to feeling a deeper sense of presence in immersive settings. This viewpoint is backed by Sas (2004) and Nicovich et al. (2005), who indicate that empathy plays a crucial role in users' engagement with VR. Participants with higher empathic sensitivity were more inclined to emotionally connect with virtual content, which in turn strengthened their sense of realism, immersion, and psychological connectedness.

Although a few studies have explored empathy's influence on presence, limited attention has been given to whether this pathway indirectly affects the persuasive efficacy of VR interventions. If people with reduced empathy are less affected by VR experiences, this would suggest a clear connection between empathy and the overall effectiveness of VR. Conversely, if empathy is simply an outcome of increased presence, then the effectiveness of VR should remain relatively consistent across individuals, regardless of their baseline empathy levels. However, if empathy drives

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presence, as some evidence suggests, then the success of VR interventions may depend significantly on individual differences in empathic sensitivity.

People often experience a gap in empathy when trying to relate to distant issues or abstract consequences—such as the effects of meat intake on animal rights and ecological preservation. Virtual reality holds the promise of bridging this divide by providing intense, immersive, firsthand experiences that make these remote realities feel more present and comprehensible. By converting abstract issues into concrete and emotionally engaging experiences, VR has the ability to alter how individuals perceive meat consumption, changing it from a distant concept to a more tangible and meaningful understanding.

Drawing from the preceding discussion, this study centers on two main research aims. The first objective is to immerse participants in a viewpoint that allows them to directly witness the suffering of an injured animal, as opposed to passively viewing processed meat products. By engaging participants in this immersive scenario, the study seeks to uncover how individuals interpret the realities of animal life and death, moreover, further examining the connection between presence and empathy.

The second objective focuses on investigating how variations in personal empathy capacity may impact the perceived immersion in virtual environments and whether this subsequently influences participants' inclination to consume meat. Addressing the increasing concerns regarding the effects of excessive meat consumption, this study also aims to examine how empathy influences the effectiveness of immersive simulations in encouraging willingness to change attitudes.

In conclusion, this study illustrates that virtual reality has the potential to decrease beef consumption by cultivating empathy, thereby advancing efforts in public health promotion. Empathy emerges as a pivotal factor—not only as a psychological construct

doi:10.6342/NTU202504615

influencing user engagement, but also as a key predictor of how effectively VR can shape behavior.

The main contribution of this study is examining empathy as a key factor in creating presence within VR settings. The findings suggest that people with higher empathy tend to experience a more intense sense of presence, which, in turn, greatly impacts their intention to decrease beef intake. In contrast to past research that viewed presence as a precursor to empathy, the current results propose an alternative causal direction, suggesting that empathy could actually lead to more intense feelings of presence. These findings highlight the significance of taking individual differences in empathy into account when developing VR-based interventions aimed at encouraging behavioral change.

1.2. Justification for Using Cows as a Research Subject

Cows are highly effective research subjects due to their physical characteristics, cultural significance, and ability to evoke empathy. As large animals, cows naturally draw stronger emotional responses compared to smaller animals like chickens or fish. Studies have shown that larger animals elicit heightened feelings of discomfort and empathy when presented in distressing scenarios. Their size symbolizes "the weight of life," making the suffering of cows more tangible and emotionally impactful. For instance, in experimental studies, participants exposed to visual representations of injured cows often report stronger emotional reactions than when shown smaller animals like chickens or shrimp. This ability to evoke intense emotional engagement positions cows as ideal subjects for empathy-related studies.

Moreover, cows have deep cultural and symbolic significance across various societies, enhancing their relevance in exploring human-animal relationships. Beyond their role as a meat source, cows are often regarded as farming companions, providers

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of milk, and symbols of productivity and abundance. In Taiwan, leisure farms frequently offer family-oriented activities such as feeding cows, riding water buffaloes, or observing herds grazing freely. These interactions reinforce the perception of cows as sentient beings with emotional and cognitive attributes, making them particularly effective for studies focusing on ethical willingness toward animals.

Globally, beef consumption holds a prominent position, making cows an essential focus for discussions on ethical and environmental concerns. Although pork is more frequently eaten in Taiwan, beef is typically regarded as a higher-end product linked to greater environmental consequences, including greenhouse gas emissions, water consumption, and land deterioration. Additionally, international awareness of animal welfare in beef production emphasizes cows as a focal point for ethical discourse. Using cows as research subjects enables the findings to resonate on a global scale, addressing broader questions of sustainability and ethical consumption.

In this study, cows are used as a "medium" to explore how their imagery and characteristics evoke empathy and influence willingness toward animals. This approach transcends the specific issue of beef consumption and focuses on emotional engagement. For instance, using virtual reality (VR) to depict an injured cow can trigger profound emotional responses, encouraging participants to reconsider their perceptions of animals and their moral responsibilities toward them. This method is similar to studies involving dogs, where even participants who do not consume dog meat can experience strong sympathy when shown images of injured dogs, leading to broader reflections on animal welfare.

However, why not pigs as the research subject?

Although pigs are central to Taiwanese cuisine and many Asian cultures, they lack the cultural depth and emotional resonance of cows. In most societies, pigs are predominantly seen as food sources rather than companions or symbols of emotional

doi:10.6342/NTU202504615

and cultural significance. In contrast, cows are often associated with farming partnerships, milk production, and even sacredness in certain cultures, such as India. These attributes make cows more likely to evoke emotional engagement and ethical reflections among participants.

Pigs' physical appearance and behavioral traits may also limit their ability to evoke empathy. Research indicates that animals with more expressive features, such as large eyes and readable facial expressions, are more likely to elicit human empathy. Pigs, lacking these characteristics, may not provoke the same level of emotional connection as cows. Furthermore, pork is a staple in Taiwanese diets, making pigs a more normalized and less thought-provoking research subject. In contrast, the relative rarity and higher cost of beef make cows a more striking and distinctive focus for studies exploring ethical considerations.

Moreover, why not fish or shrimp as research subjects?

Fish and shrimp are less effective as research subjects due to their smaller size and limited ability to evoke strong emotional responses. Humans are generally less empathetic toward aquatic animals, perceiving their deaths as less impactful or significant. Their lack of facial expressions and relatable behaviors further reduces their capacity to generate emotional engagement. Moreover, fish and shrimp's aquatic habitat and minimal interaction with humans create a psychological distance, making it harder for participants to empathize with their suffering.

Fish and shrimp are also often considered lower life forms with minimal ethical or cultural significance. While welfare concerns about large-scale fishing and bycatch exist, they receive far less public attention than issues related to the welfare of land animals like cows or pigs. This diminished cultural and ethical relevance makes fish and shrimp less suitable for studies aiming to explore empathy and ethical behavior toward animals.

doi:10.6342/NTU202504615

Addressing concerns about beef accessibility and cost, it is acknowledged that beef's high price may limit its availability for certain demographics, such as students. Nonetheless, this does not undermine cows' effectiveness as research subjects. The study focuses not on participants' actual consumption habits but on their emotional and ethical responses to cows as sentient beings. In fact, the premium status of beef highlights its environmental and ethical implications, prompting participants to critically evaluate the broader consequences of consuming such a resource-intensive product. Furthermore, the cultural and symbolic significance of cows extends beyond their role as a food source. By using VR or visual media to depict cows' suffering, participants can engage with the research themes even if they rarely consume beef. This ensures that the findings remain relevant and impactful across different dietary habits and cultural contexts.

By addressing these points, the study can effectively explore how empathy influences willingness toward animals and ethical behavior, with cows serving as the most impactful and representative research subject.

doi:10.6342/NTU202504615

CHAPTER TWO

LITERATURE REVIEW AND HYPOTHESES

Understanding the factors that influence individuals' willingness to adopt certain choices has been a central focus in psychological and social science research. Traditionally, attitude has been regarded as a key determinant in shaping people's decisions, reflecting their positive or negative evaluations of a particular action. Nevertheless, research has indicated that attitudes by themselves do not always result in willingness (Wicker, 1969). This limitation has prompted scholars to explore alternative constructs, among which willingness has gained increasing attention. Unlike attitude, which is relatively stable and reflective, willingness is more dynamic and context-dependent, making it particularly relevant in situations where individuals have limited prior experience or have not formed explicit intentions.

The introduction of Virtual Reality (VR) being a research method presents novel opportunities for studying psychological mechanisms. that influence willingness, particularly through its capacity to evoke empathy and presence. In contrast to conventional media, VR's immersive quality enables people to participate in experiences that replicate real-life situations, turning abstract ideas into more concrete ones. Empathy, the capacity to comprehend and connect with the emotions of others has been acknowledged as a crucial element in influencing willingness, particularly in areas involving ethical choices, social accountability, and environmental consciousness. Additionally, the concept of presence—the feeling of 'being present' in a digital setting—has been suggested to enhance the effectiveness of VR experiences by increasing emotional and cognitive engagement. Despite these theoretical advancements, there remains a need for further exploration into how empathy and presence interact to influence willingness in specific decision-making contexts.

doi:10.6342/NTU202504615

While earlier studies have examined the capabilities of VR in fostering awareness and promoting various forms of engagement, studies have yet to systematically examine how empathy and presence contribute to individuals' willingness to make changes in their consumption patterns. The relationship between these psychological mechanisms is not yet fully understood, and it remains unclear whether presence enhances empathy or whether empathy independently influences willingness. Given these gaps, this study seeks to examine how VR-facilitated empathy and presence shape individuals' willingness in decision-making processes.

This chapter reviews the theoretical and empirical foundations relevant to this study. It first discusses the distinctions between attitude and willingness, highlighting the reasons why willingness is a more suitable construct in certain contexts. Next, it examines empathy as a psychological mechanism and its role in shaping individuals' perspectives and choices. It then explores the concept of presence in VR, outlining its significance in immersive experiences. Finally, it reviews prior research on VR-facilitated interventions and identifies the existing gaps that this study aims to address. Through this literature review, this research seeks to build a comprehensive theoretical framework for understanding how VR can be utilized to influence willingness through empathy and presence.

2.1. Attitude and Willingness in Behavioral Prediction

Investigating the determinants of human judgment remains a primary focus in psychology and the social sciences. Traditionally, attitudes—which reflect peoples' favorable or unfavorable evaluations of a particular behavior—have been considered primary predictors of behavioral intentions and actions. Nevertheless, research indicates that attitudes alone do not consistently predict behavior, accounting for only a modest portion of behavioral variance (Janeksela, 1978; Wicker, 1969). This

doi:10.6342/NTU202504615

discrepancy has led scholars to explore alternative constructs, such as willingness, to enhance the predictive accuracy of behavioral outcomes.

Attitudes are complex constructs that integrate cognitive, affective, and behavioral components and are recognized as multidimensional in social science research (Hayes & Darkenwald, 1990). They are bipolar in nature, indicating that they may be either beneficial or detrimental, desirable or undesirable and function as responses to people, objects, or situations. Since attitudes are latent psychological constructs that cannot be directly observed, their measurement relies on inferred responses from actions and words. Given this limitation, it may be more effective to correlate multiple attributes to enhance measurement accuracy. Wicker (1969) found that attitudes account for only about 10% of behavioral variability, highlighting their limitations as sole predictors (Janeksela, 1978).

Willingness is defined in various ways. Merriam-Webster defines "willing" as having a positive or favorable attitude or agreeing to something voluntarily without hesitation. Other definitions describe willingness as the characteristic of being eager to do something when required or being set and ready to take action.[5]. Unlike intention, willingness often involves minimal forethought and is a stronger indicator of behaviors that occur outside routine activities or in situations where individuals lack prior experience. As a key factor in decision-making and choice, willingness is shaped by a person's worldview and interpretation of a given situation. It is closely linked to the evaluation of advantages, disadvantages, costs, and benefits, both consciously and unconsciously. Through willingness, decision-makers identify opportunities and transform them into viable alternatives. The Prototype Willingness Model (PWM) was developed to elucidate complex behavioral patterns, especially those related to risk-

[5] https://dictionary.cambridge. org/us/dictionary/english/willingness. Accessed January, 9, 2025.

doi:10.6342/NTU202504615

taking behaviors (Gibbons & Gerrard,). Empirical research has validated the model by demonstrating that individuals' perceptions of risk-related prototypes are closely linked to their readiness to engage in related behaviors.

Using willingness rather than attitude depends on research objectives, conceptual applicability, and behavioral prediction accuracy. While attitude reflects an individual's evaluation of something—whether positive, negative, or neutral—it is a relatively stable construct and does not necessarily result in action. For example, an individual may hold a favorable view toward environmental conservation, but that doesn't necessarily mean they are inclined to contribute to an environmental charity. On the other hand, willingness signifies the probability of participating in a particular action in a specific situation.

Although influenced by attitude, willingness is also shaped by environmental factors, social norms, and personal capabilities. In situations where individuals lack clear plans, willingness serves as a stronger predictor of behavior. For example, stating "I am willing to donate" is a better predictor of actual donations than merely expressing a positive attitude toward environmental protection.

Willingness has been demonstrated to be a more accurate predictor of behavior than attitude in various research contexts.Traditional attitude research measures people's views and evaluations, but attitudes do not always lead to action. Even individuals with strong pro-environmental attitudes may fail to take action due to constraints such as time or financial limitations. Willingness has been shown to be a stronger indicator of behavior than attitude in various research contexts with willingness serving as a type of behavioral intention (Ajzen, 1991; Lin & Roberts, 2020).Furthermore, while attitudes are often tied to existing values and habits, willingness is more predictive of new or unplanned behaviors, such as trying a plant-based diet or attending an environmental event for the first time. Since willingness

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reflects spontaneous decision-making, it does not necessarily require long-term attitude formation. Empirical studies have consistently demonstrated that willingness is a more effective predictor of behavior than attitude. Research on pro-environmental behavior indicates that assessing consumers' readiness to spend more on eco-friendly products provides more precise understanding of their actual buying choices than merely evaluating their environmental attitudes (Joung et al., 2014; Zhan et al., 2025).

In the same way, in health behavior research, measuring individuals' willingness to receive a vaccine has been found to be a stronger predictor of vaccination rates than assessing their attitudes toward vaccination (Wake, 2021). In the domain of risk behavior research, willingness has been shown to be more effective than attitude in predicting impulsive or low-experience behaviors, such as whether adolescents are willing to try smoking.

Given its stronger predictive power, particularly in situations where behavior is influenced by spontaneous or external factors, this study adopts willingness rather than attitude as the key construct for understanding behavioral outcomes. By focusing on willingness, this research aims to enhance the accuracy of behavioral predictions and contribute to a deeper understanding of decision-making processes across various domains.

2.2. Empathy

Empathy is broadly regarded as a multifaceted psychological idea, incorporating both cognitive and emotional elements. It involves the capacity to recognize, comprehend, and emotionally connect with the experiences of others (Cohen & Strayer, 1996). Davis (1983) describes empathy as an individual’s emotional reaction to observing someone else’s feelings, often demonstrated through spontaneous, vicarious emotional sharing.

doi:10.6342/NTU202504615

Although the definitions of empathy vary across different fields, researchers generally agree on its fundamental characteristics. Zaki (2014) and Decety and Jackson (2004) have pointed out the broad spectrum of definitions in the literature, highlighting the complexity of the concept. Hoffman (2002), for example, describes empathy as the capability to recognize, comprehend, and mentally relate to the feelings experienced by others. Empathy can be elicited by witnessing someone else's emotional state or circumstances, allowing individuals to form emotional connections with others without requiring firsthand experience.

Decety and Jackson (2004) present a framework for understanding empathy that encompasses three interconnected elements: emotional sharing, self-other distinction, and cognitive adaptability with emotional control. Affective sharing arises from the natural willingness of humans to mirror others' emotions, which is evident even in infancy. Self-other awareness, another critical component of empathy, allows individuals to differentiate between their own emotions and those of others. This distinction is essential for avoiding over-identification with others' feelings, which could lead to emotional contagion or confusion between personal and external emotional states. It ensures that while individuals can resonate with others emotionally, they maintain clarity about the source of those emotions. The third element, cognitive adaptability and emotional regulation, pertains to the ability to take on another's viewpoint while controlling one's own emotional reactions. Perspective-taking enables individuals to understand situations from another person’s viewpoint, while emotion regulation ensures that empathy does not overwhelm them, allowing for constructive responses (Decety & Jackson, 2004).

Empathy is a complex interplay of emotional resonance, cognitive perspective-taking, and emotion regulation (Decety & Jackson, 2004).These components work together to enable individuals to connect with others, navigate social interactions, and

doi:10.6342/NTU202504615

engage in prosocial behaviors. Its dual nature as both a stable trait and a dynamic capacity highlights its importance in fostering meaningful relationships and addressing societal challenges.

Furthermore, empathy plays a crucial role in various domains of human interaction. In healthcare, empathy is essential for building trust between patients and providers, improving communication, and ultimately enhancing patient outcomes. Healthcare professionals who demonstrate empathy are better able to understand patients' concerns and provide care that is both compassionate and effective (Clark, 2010; Cuff et al., 2016; Nightingale et al., 1991).

While Decety and Jackson (2004) proposed a functional model of empathy comprising three interrelated components, most scholars commonly distinguish between two primary forms: cognitive empathy and affective empathy (Bertrand et al., 2018; Davis & Franzoi, 1991; Decety & Jackson, 2004; Eisenberg & Strayer, 1987; Fan et al., 2011; Keen, 2006).

Affective empathy involves experiencing another's emotional states, allowing individuals to feel emotions that align with those of others. Cognitive empathy, in contrast, entails taking on another person's viewpoint and comprehending their thoughts and mental conditions. Affective empathy allows individuals to feel emotions that mirror those of others, such as sadness, joy, or distress, while cognitive empathy facilitates the intellectual understanding of why someone feels or acts in a particular way. These elements work together to help individuals build meaningful connections with others on emotional and cognitive levels, strengthening interpersonal bonds and promoting social unity.

Empathy is generally seen as a fairly consistent personal trait or ability, representing a stable inclination to react empathetically across different situations (Cuff et al., 2016). This perspective implies that variations in emotional sensitivity and the

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capacity to adopt others' viewpoints are based on lasting personality traits rather than temporary situational factors. People possessing elevated trait empathy levels tend to engage in compassionate behaviors more frequently, whether in familiar or unfamiliar environments, regardless of external factors.These stable characteristics are often linked to early life experiences, genetic predispositions, and socialization processes, which together shape a person's natural disposition toward empathy.

Although empathy is often conceptualized as a relatively fixed trait, it can also be influenced by contextual or situational factors. For instance, exposure to narratives, visual media, or real-life scenarios that highlight the emotional experiences of others can evoke empathic responses, even in individuals who may not typically display high levels of empathy. Research has demonstrated that immersive technologies, such as virtual reality (VR), can enhance empathy by creating environments where users experience the perspectives and emotions of others in a more visceral and direct way (Bertrand et al., 2018). Similarly, interventions such as mindfulness training and perspective-taking exercises have shown promise in fostering empathy, suggesting that while trait empathy may be stable, state empathy—the capacity to feel empathy in specific moments—can be cultivated through targeted efforts.

2.2.1. Cognitive Empathy and Affective Empathy

When examining the effect of virtual reality on empathy, it is essential to differentiate its cognitive and emotional aspects. Although these two elements are interconnected, they serve different functions in emotional regulation. Smith and Stamoulis (2023) characterize cognitive empathy as the ability to comprehend the emotional experiences of others from a detached and analytical perspective. This form of empathy aids emotional regulation by fostering adaptive techniques such as cognitive reappraisal, thus reducing emotional instability. On the other hand, affective

doi:10.6342/NTU202504615

empathy involves deeply immersing oneself in others' emotional experiences, which can amplify personal emotional reactions and hinder self-regulation. Therefore, while cognitive empathy typically promotes emotional balance, affective empathy may, in certain circumstances, impede it (Smith & Stamoulis, 2023).

These two components, while distinct, often work together to create a comprehensive empathetic response. For example, affective empathy might allow someone to feel sadness when witnessing another person's distress, while cognitive empathy enables them to understand the reasons behind the distress and respond appropriately. The balance between these components can vary depending on the context. In professional settings, such as healthcare, cognitive empathy may dominate as practitioners focus on understanding and addressing patients' needs without becoming overwhelmed by their emotions. Conversely, in personal relationships, affective empathy often plays a more prominent role, deepening emotional bonds and mutual understanding.

Research highlights that the development of affective and cognitive empathy is shaped by various factors, such as family dynamics, peer interactions, cultural norms, and mental health. Positive family relationships characterized by warmth and support significantly contribute to the development of both components, while exposure to conflict or neglect can hinder their growth. In the same way, strong peer relationships foster perspective-taking and emotional exchange, enhancing both cognitive and affective empathy. Conversely, negative experiences such as bullying or exclusion can impair these capacities, leading to difficulties in social interactions (Smith & Stamoulis, 2023).

Affective and cognitive empathy also play crucial roles in shaping prosocial behaviors. Affective empathy drives compassionate responses, motivating individuals to alleviate others' suffering. Cognitive empathy, in turn, facilitates effective

doi:10.6342/NTU202504615

communication and problem-solving by enabling individuals to consider others' viewpoints. Together, they foster social harmony and cooperation, which are essential for functioning communities.

In their study on the connection between justice sensitivity and components of empathy, Decety and Yoder (2016) found that affective empathy did not show a significant correlation with individuals' responsiveness to justice-related concerns. Rather, cognitive empathy and empathic concern were identified as the primary predictors, both contributing to stronger adherence to moral principles. These findings imply that cognitive empathy may have a greater impact on shaping one's sense of social justice.

Even though affective empathy generally increases with age, certain aspects of cognitive empathy appear to decline, potentially explaining the challenges older adults encounter when accurately understanding emotional signals. These studies illustrate the distinct functional roles and developmental pathways of cognitive and affective empathy in understanding emotions and participating in social interactions.

2.2.2. Empathy, Compassion, and Sympathy

While empathy has garnered significant focus in psychological studies, compassion and sympathy are also acknowledged as key prosocial emotions. Although these concepts exhibit commonalities and sometimes intersect with empathy, they vary greatly regarding their duration over time and dependence on circumstances. Compassion, for example, is described by Goetz et al. (2010) as an emotional response triggered by observing another person's suffering, typically accompanied by a desire to relieve it. In contrast to empathy, commonly viewed as a stable personality trait, compassion is typically considered a fleeting emotional response activated by immediate situational indicators and gradually fades as those indicators diminish. Its

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context-dependent nature sets it apart from empathy, as it does not represent an enduring psychological trait (Goetz et al., 2010).

Sympathy, similarly, is understood as a context-dependent emotional reaction marked by concern or sadness when witnessing someone else's suffering. Eisenberg et al. (1994) define sympathy as an affective reaction based on awareness of another person's emotional state, ranging from minor discomfort to intense suffering. In contrast to empathy, which requires internalized emotional resonance and perspective-taking, sympathy may occur more reflexively, often as a surface-level response. It is also frequently considered a follow-up reaction to empathy, emerging after the initial experience of emotional attunement or shared affect (Eisenberg et al., 1994; Sinclair et al., 2017).

These differences underscore the distinct psychological profiles of empathy, compassion, and sympathy. Compassion and sympathy tend to be more fleeting and situational, while empathy is generally considered as a more fixed and enduring trait that develops over time and becomes integrated into an individual's cognitive and emotional processing.

Building on this distinction, Singer and Klimecki (2014) propose that empathy operates as an inherent characteristic that is stable across different circumstances, helping individuals consistently express empathetic responses. This enduring quality enables empathy functions as a dependable foundation for comprehending others and managing social interactions. On the contrary, compassion and sympathy are more reactive, arising in reaction to particular situations and dissipating once those situations are resolved. Condon and Barrett (2013) describe compassion as a "situated conceptualization," shaped by immediate contextual factors and prone to rapid changes. Barrett and Naughton (2014) further support this idea, highlighting that such emotions are not static, but are dynamically formed based on fluctuating external signals.

doi:10.6342/NTU202504615

This theoretical distinction is crucial to the structure of the current study. By characterizing empathy as a consistent internal characteristic and viewing compassion and sympathy as situationally influenced emotional responses, we suggest that empathy is essential in shaping participants' experiences in virtual reality (VR). The study indicates that individuals possessing higher levels of innate empathy are more likely to experience a heightened sense of immersion in VR environments, which in turn influences their perceptions and responses. From this perspective, empathy acts as a consistent predictor of how users interact with immersive content, underscoring its significance in the design of VR-based behavioral interventions.

However, if it is assumed that presence in virtual reality is mainly influenced by situational emotions like compassion and sympathy, the core argument of this study becomes contradictory. Whereas empathy is generally regarded as a consistent trait, compassion and sympathy are more fleeting and context-dependent, making them unreliable indicators of presence. As such, participants' experience of presence—and their willingness to engage in behavioral change—may be more influenced by temporary emotional states or specific environmental cues within the VR setting, rather than by stable personal dispositions. This perspective stands in contrast to the objective of the present study, which seeks to explore how enduring internal traits shape VR experiences. Focusing on short-lived emotions like compassion and sympathy would shift the emphasis toward external influences, diverting attention from the internal psychological characteristics that are central to our research framework.

In conclusion, conceptualizing empathy as a stable, dispositional trait—rather than the context-dependent nature of compassion and sympathy—strengthens the theoretical foundation of this study. Since empathy tends to remain consistent across various situations, it offers a reliable basis for forecasting users' sense of presence and their behavioral reactions in immersive VR environments. In contrast, the variability and

doi:10.6342/NTU202504615

situational reliance of compassion and sympathy make them less appropriate for studying the lasting effects of personality traits. As such, this research emphasizes how enduring individual traits, like trait empathy, shape user engagement and behavioral outcomes in virtual reality, instead of focusing on transient emotional responses.

2.2.3. Empathy toward Humans and Animals

Studies on empathy towards both humans and animals have attracted significant focus, providing valuable insights into the relationships between these empathetic reactions. Taylor and Signal (2005) examined how empathy for humans is linked to empathetic attitudes towards animals. Their results showed that individuals exhibiting greater empathy towards humans were also more inclined to show concern and care for animals.This study highlights empathy as a core factor influencing perceptions and moral consideration of animals, underscoring the ethical dimensions of human-animal relationships.

In related research, Westbury and Neumann (2008) explored empathy-driven reactions to audiovisual stimuli featuring both people and animals in distress. They found a distinct trend showing that empathy levels and physiological arousal—assessed through corrugator EMG activity and skin conductance responses (SCRs)—were stronger when participants observed species more closely related to humans. These findings reinforce the idea that human empathy is not species-specific and may generalize to other animals, particularly those with higher phylogenetic proximity to humans.

Paul (2000) further investigated the connection between empathy for humans and empathy for animals, confirming a strong positive correlation between the two. Individuals who demonstrated high levels of empathy toward humans were also more

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inclined to show compassionate care for animals, reinforcing the idea of empathy as a universal characteristic that crosses species boundaries.

In recent years, empathy toward animals has drawn increasing scholarly and interdisciplinary interest, spanning disciplines such as psychology, philosophy, cultural and historical studies, animal welfare science, human-animal studies, and advocacy-related fields (Aaltola, 2012; Bradshaw & Paul, 2010; Cowie, 2014; Paul, 2000; Phillips, 2009).

Many publications argue that empathy can be the foundation for a new and ethically superior model of human-animal relationships compared to those currently prevalent in contemporary societies (Bekoff, 2010). Therefore, empathy for animals has evolved into a subject with significant social implications in addition to academic interest.

Animal empathy describes an emotional response elicited by the distress or pain experienced by animals, which differs from empathy directed towards humans (Rothgerber & Mican, 2014). Recent studies have found a link between increased levels of animal empathy and reduced meat consumption. (Zickfeld et al., 2018). Research has also shown that vegetarians and vegans display heightened activity in brain areas associated with empathy when exposed to images of animals in pain, in contrast to meat eaters (Camilleri, Gill, and Jago, 2020; Filippi et al., 2010).

Willingness, beliefs, and values that individuals hold towards an object or event are often predictive of their subsequent behavior towards it (Fishbein & Ajzen, 2010). Ongoing research has evaluated the link between willingness towards animals and individuals' behavior towards them (Apostol et al., 2013; Kavanagh et al., 2013; Zalaf & Egan, 2015). One prominent theme in this research is the pivotal role of human-directed empathy in influencing willingness toward and treatment of animals (Taylor & Signal, 2005). Studies have suggested that human-directed empathy is a mediating factor in the link between human-animal violence and that willingness towards animals

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may be related to certain components of human-directed empathy (Hastings et al., 2000; Parkes & Signal, 2017; Warden & Mackinnon, 2003). Moreover, the readiness to empathize with animals may be connected to particular facets of empathy towards humans, such as compassion and awareness of others' emotions (Furnham et al., 2003; Morton & Daly, 2008; Signal et al., 2017).

Colombo et al. (2019) used veterinary practice as an example to apply human's empathy towards animals. Carney et al. (2012) conceptualized veterinary medicine as a blend of scientific knowledge and humanistic sensitivity, where science pertains to the use of empirical evidence, and art refers to interpreting an animal's mental state and demonstrating empathy as part of the therapeutic process. Echoing this perspective, Martinsen (2007) argued that a compassionate approach can enhance the recognition of animal suffering, particularly because animals are unable to verbally express their symptoms. While diagnostic procedures may be conducted solely based on observable signs, a truly comprehensive evaluation of an animal's condition should also include an empathetic understanding of its emotional state—achieved by adopting the animal's perspective.

These studies emphasize the shared foundation of empathy in human-animal relationships. Instead of being limited to interactions within the same species, empathy can extend across species boundaries. People with higher levels of empathy for humans often show similar concern for animals, indicating a broad, generalized ability for compassion.

Building on this evidence, it is reasonable to conclude that individuals with stronger empathic traits are more likely to reassess their dietary choices due to concerns about animal welfare. Specifically, compassionate responses toward creatures—especially when faced with their situations in industrial agriculture—may provoke heightened emotional discomfort and reduce the willingness to consume beef.As

doi:10.6342/NTU202504615

individuals become more sensitive to the suffering of animals, their eating behaviors may change accordingly. These findings support the notion that empathy-driven interventions, such as VR experiences that vividly depict animal suffering, can be powerful tools in influencing consumer attitudes and decreasing meat consumption.

2.3. Virtual Reality and Empathy

Virtual reality (VR) represents an innovative medium that enables users to enter highly immersive and interactive digital environments, producing a vivid sense of presence within both real and simulated worlds. By utilizing head-worn displays and multisensory input devices—such as motion trackers, haptic feedback systems, and spatial audio—VR immerses users in alternative realities by engaging multiple senses simultaneously. In contrast to traditional media, which rely on passive viewing, VR transforms the user's experience by positioning them as an active agent who can navigate, manipulate, and impact the virtual setting instantly.

One of the key characteristics of VR is its capacity to replicate environments with such depth and detail that it elicits powerful emotional and cognitive reactions. For instance, VR enables users to step into scenarios that would otherwise be inaccessible—whether that means exploring distant historical events, walking through abstract conceptual spaces, or participating in complex narratives. This immersive quality has significant implications for storytelling and persuasion, as users connect with characters and environments in a deeply personal way. VR storytelling disrupts traditional narrative structures, allowing for nonlinear exploration and the blending of audience agency with character development (Nicovich et al., 2005; Shin, 2018).

Moreover, VR's interactivity and sensory immersion have far-reaching applications beyond entertainment. In education, VR allows learners to engage directly with subjects such as history, science, or art, fostering experiential learning. In

doi:10.6342/NTU202504615

healthcare, VR is being used for therapeutic interventions, such as treating phobias, PTSD, and chronic pain. In marketing and advertising, VR provides an unparalleled platform for creating memorable brand experiences, enabling consumers to "try" products or services virtually. These applications showcase VR's ability to create transformative experiences that surpass conventional methods of involvement (Sanchez-Vives & Slater, 2005; Wan et al., 2022).

Central to the effectiveness of VR is its ability to replicate or reinterpret reality while immersing users in a controlled yet believable environment. This capacity to simulate "as-if-real" conditions makes VR an effective medium for fostering empathy, enhancing learning outcomes and influencing decision-making. For example, VR has been employed to increase understanding of social issues by positioning users in the perspective of others, helping them experience the world through a different lens.Such applications demonstrate how VR extends beyond mere entertainment, offering tools for meaningful change and innovation.

As a medium, VR has revolutionized how people perceive and interact with digital spaces. By transforming passive spectators into active participants, VR is reshaping not only entertainment and storytelling but also industries like education, healthcare, and marketing. This continuous development positions VR as a technology with the capability to reshape how we perceive, learn, and interact in today's world.

Virtual reality (VR) is frequently described as the "ultimate empathy machine," a term coined for its ability to generate a strong sense of presence through advanced immersive technologies. Presence is considered a fundamental condition for eliciting empathy, with VR's immersive features providing an ideal setting for empathic involvement (Schutte & Stilinović, 2017). Additionally, the degree of presence in a virtual setting is deemed essential for fostering empathy, as it determines how deeply

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users feel emotionally connected to the simulated experience (Barbot & Kaufman, 2020).

While these viewpoints focus on the role of presence in triggering empathic reactions—contrary to this study's hypothesis that empathy could precede presence—they still provide meaningful perspectives on the wider comprehension of empathy growth in virtual settings.

Empathy is widely regarded as a major driver of prosocial behavior, and scholars have utilized various mediated perspective-taking methods to evoke empathic responses. Research indicates that engaging with VR content specifically designed to foster empathy can boost individuals' involvement in related social or environmental causes. Herrera et al. (2018) indicated that individual who took part in immersive settings experiences designed to elicit empathy were notably more inclined to sign a petition associated with the issue introduced, compared to those who viewed the same content via non-immersive media. Along similar lines, Ahn's study on assisting a colorblind person provides another example of how VR can inspire prosocial behavior. In Ahn's design, participants were exposed to two different VR conditions. In one, they wore a head-mounted display (HMD) with a color filter, making them experience colorblindness. In the other, participants wore HMDs without a filter, mimicking the experience of a typical person who can perceive colors.

Participants in both conditions spent around 15 minutes exploring the virtual world. After the VR interventions, Participants were requested to complete a survey with regard to their willingness toward colorblind people. When participants completed the questionnaire, the researcher told them the experiments ended and they could leave the lab. The researcher later left the room. Nonetheless, the experiments did not "truly" end. In the beginning, there was a colorblind person doing a color-match practice in the lab. That person asked participants who completed the questionnaire for help him or her

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finish the practice.

The amount of time participants dedicated to helping the colorblind person was considered voluntary and was measured as prosocial behavior. The outcomes indicated that participants who “were” colorblind in the immersive world spent significantly more time assisting the colorblind person than those whose eyes were also normal in virtual world. The mechanism behind the prosocial behavior is what Ahn called self-other merging into “oneness” as well as empathy. Empathy is an emotion that people feel when others suffer and feel the same feeling such as sadness and distress. In the experiment, participants personally experienced what colorblind people see, and the difficulty of not being able to distinguish colors other than black and white triggered their empathic concern. As a result, they were more inclined to dedicate additional time assisting the colorblind individual.

In a two-part investigation, Herrera et al. (2018) examined the comparative impacts of traditional and virtual reality (VR) perspective-taking tasks. Study 1 explored both the immediate and long-term outcomes of these interventions. Although participants in both groups reported similar levels of empathy and connectedness toward the homeless over an eight-week period, those who engaged in the VR simulation displayed greater sustained behavioral willingness.

Study 2 further investigated how varying levels of immersion in perspective-taking activities—namely traditional, desktop-based, and VR formats—as opposed to a control group that received solely factual information. In all perspective-taking scenarios, participants showed greater empathy and a stronger sense of connection to the homeless in contrast to participants in the baseline group. However, mirroring the results observed in Study 1, self-reported levels of empathy did not vary significantly between the immersive conditions. Nevertheless, participants in the VR group exhibited a notably higher likelihood of signing a petition supporting affordable housing,

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suggesting that immersive experiences may enhance behavioral outcomes more effectively than traditional or less immersive formats.

These results provide significant theoretical and practical insights from a viewpoint of how immersive technology can enhance empathy and promote helpful behavior.

Gillath, McCall, Shaver, and Blascovich's (2008) main research goal was to delve into whether people would respond to events in the real world as they would to occurrences in a simulated setting.The authors focused on people's empathic concern and reaction to virtual persons in need. As for their expectations, they intended to know if people who had higher dispositional compassion scores would be "positively correlated with expressions of care and inclination to help (Gillath et al., 2008)."

The authors were convinced that the two indicators could be a reliable measurement of prosocial willingness—the compassion scale and emotional distress ("willingness to feel distressed in the face of someone else's suffering," p. 267). Their final findings supported their hypotheses, showing that participants who scored higher on the compassion scale and had higher emotional distress were more willing to get closer to and stayed more time with the virtual person in need (a beggar) than participants who scored lower on the compassion scale. They conducted two studies. For Experiment 1, participants wore a head-mounted display (HMD) and were located on a virtual urban street. However, they were asked to sit on a bench to observe the street. Then, they saw an old blind man with a cane hit by a car, and the cane was dropped and fell far from the man. Later, the blind man asked for help. After seeing the scenario, the participants were told to fill out several emotional inventories and a survey inquiring about their empathy and willingness to assist. The results indicated that participants with higher compassion scale scores verbally expressed more concern

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toward the individual in need and were more willing to assist the virtual person compared to those with lower scores on the scale.

In Experiment 2, participants were given the freedom to move around within the virtual environment. During the scenario, they encountered a beggar and a businessman. Participants with higher compassion scores and greater emotional discomfort tended to approach and spend more time with the beggar compared to those with lower compassion scores. However, one significant drawback of the study is that merely moving closer or spending more time with the virtual character does not necessarily indicate that participants would offer help in real life.

2.4. Presence

Presence is a mental state in which users experience the simulated world as authentic and tangible, responding to it as though it were a part of their physical world. It goes beyond passive observation, engaging users emotionally and cognitively in ways that feel authentic and immediate. Scholars have stressed the significance of presence as a core component of VR, underscoring its role in generating meaningful and immersive experiences (Camilleri & Jago, 2020; Jennett et al., 2008; Slater & Steed, 2000). By fostering presence, VR transcends the limitations of traditional media, engaging users in highly interactive and emotionally resonant ways. For instance, in a virtual classroom setting, presence can make students feel as though they are physically present, enhancing learning outcomes and engagement (Lombard & Ditton, 1997).

The creation of presence involves a complex interplay of technological, sensory, and psychological factors. One critical component is sensorimotor loop consistency, where sensory feedback must be synchronized with users' movements and actions in real time. For example, when users turn their heads, the VR system must immediately adjust the visual field to match their perspective. Any delay or mismatch in this

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feedback loop can disrupt the illusion of presence and remind users of the artificiality of the experience (Slater & Steed, 2000). Another key factor is statistical plausibility, which ensures that the virtual environment aligns with users' expectations of natural settings. Even without photorealistic graphics, the brain can interpret sensory data as plausible if it aligns with prior experiences and logical expectations (Lee et al., 2023). Lastly, behavior-response correlations are essential, requiring the virtual environment to respond appropriately and accurately to users' actions. For instance, if users pick up a virtual object or touch an element in the environment, the system must provide immediate and coherent feedback to reinforce the illusion of interacting with a real-world object (Tham et al., 2018).

Presence operates across multiple dimensions, encompassing unconscious physiological reactions, semi-conscious behavioral shifts, and deliberate cognitive engagement. These aspects enhance the emotional and mental richness of VR experiences. For example, even when users are aware that they are in a simulation, VR environments with high presence—such as those simulating extreme heights or dangerous situations—can evoke visceral responses like fear or hesitation, similar to reactions in the physical world (Jennett et al., 2008). Such experiences show how presence can blur the distinction between the simulated and the actual, bolstering a feeling of genuineness that strongly captivates users.The emotional resonance created by presence is particularly significant. High-presence VR experiences can elicit emotions that mirror those in real-life situations, such as empathy, excitement, or even anxiety. This has far-reaching implications beyond entertainment, including education, therapy, and social interaction (Wan et al., 2022). For example, VR applications designed for training or therapeutic purposes often rely on presence to create realistic and impactful scenarios that enable users to practice skills or confront challenges in a controlled but immersive environment. In educational settings, the use of presence can

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foster a stronger connection to learning materials by creating environments that feel engaging and interactive, leading to improved retention and understanding.

Lombard and Jones (2015) describe presence as a psychological state in which individuals perceive virtual stimuli as if they were real, incorporating both sensory and cognitive elements. This definition highlights the inherently subjective nature of presence, which can vary among individuals depending on factors such as personal involvement. New users of VR may report a heightened sense of immersion due to the novelty of the interaction, while more experienced users may evaluate their immersion based on the realism or consistency of the content itself. Elaborating on this concept, Lombard and Ditton (1997) indicate presence as the sensory perception of unmediated experience—where individuals are completely engaged in the virtual environment, instead of simply watching it through a technological interface. This immersive effect is often facilitated by multi-sensory stimulation, including visual, auditory, and sometimes haptic feedback, which together create a fully engaging and realistic experience (Herrewijn et al., 2021).

Finally, presence is not merely a byproduct of technological advancements but a carefully cultivated phenomenon that hinges on the design and execution of virtual environments. Effective VR systems must align with human perceptual and behavioral patterns, creating experiences that feel both intuitive and compelling. By leveraging the principles of presence, VR developers can design applications that redefine user engagement, facilitating impactful experiences across entertainment, education, wellness, and beyond. As virtual reality technology advances, presence remains a cornerstone of its research and development, offering profound insights into how immersive technologies can bridge the gap between the virtual and the real (Sanchez-Vives & Slater, 2005).

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2.5. VR and Presence

Presence is a core psychological aspect of virtual reality (VR), commonly understood as the personal sensation of "being there" within a digitally generated environment (Heeter, 1992). This experience, often referred to as place illusion, captures the feeling of truly existing within the virtual world (Slater, 2009). While immersion relates to the technical aspects of VR—such as visuals, interactivity, and sensory feedback—presence is shaped by the user's unique perception and involvement (Sánchez-Vives & Slater, 2005; Oh & Bailenson, 2017).

Virtual reality is often characterized as the "ultimate tool for empathy" due to its capacity to enhance the feeling of presence, which can facilitate empathetic engagement. Schutte and Stilinović (2017) suggested that a deep sense of immersion acts as a basis for empathy to grow. Likewise, the extent of immersion in a VR setting influences how empathy contributes to users' emotional involvement with simulated scenarios (Barbot & Kaufman, 2020).Their findings suggest that increased presence improves the authenticity of users' emotional and cognitive responses, thereby boosting empathy.

While these studies propose that presence comes before empathy—a perspective that contrasts with our theoretical position that empathy might come before presence—yet they still provide valuable understanding and context for the current discussion. about how immersive technologies affect emotional processes.

By integrating these viewpoints, empathy arises as a multifaceted, intricate quality" that can be developed through experiences that blend cognitive comprehension with emotional connection. Virtual reality (VR) offer a powerful medium for cultivating empathy by immersing users in highly realistic, yet controlled, simulated environments. These environments replicate complex real-world scenarios, allowing users to engage in experiential learning that supports the development of empathic abilities.

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Building on prior studies (Bertrand et al., 2018; Schutte & Stilinović, 2017; Shin, 2018), this section explores how virtual reality (VR) intersects with various aspects of empathy. Cognitive empathy refers to the mental capacity to recognize and accurately understand another individual's emotional and psychological states (Decety & Jackson, 2004; Schutte & Stilinović, 2017). VR supports cognitive empathy by enabling individuals to virtually experience the perspectives of others, fostering a deeper intellectual understanding of different viewpoints. In contrast, affective empathy involves emotionally connecting with another person's feelings—emotionally resonating with their emotional states (Batchelder & Ashwin, 2017; Kors et al., 2016; Shamay-Tsoory et al., 2009). The immersive and emotionally charged nature of VR makes it particularly effective in amplifying these emotional connections, rendering the simulated experience both immediate and authentic.

To further distinguish these two facets of empathy in the context of VR, several empirical investigations provide valuable insights. Cummings et al. (2022) indicate that cognitive empathy is predominantly impacted by the user's feeling of presence rather than their actual position within the virtual environment. Simultaneously, both one's sense of location and presence substantially heightened emotional empathy, indicating that the deeper the users' immersion in the narrative context, the more powerful their emotional reactions toward the characters grew.

In a separate study, Bacca-Acosta et al. (2023) examined the effects of two VR simulations portraying the experiences of migrants in Colombia. Forty-seven university students participated and completed self-reported measures assessing both cognitive and emotional empathy. The results revealed that while the VR experience effectively enhanced emotional empathy, it did not significantly impact cognitive empathy. This indicates that virtual reality might be especially skilled at eliciting emotional responses yet comparatively weaker in promoting a more profound intellectual comprehension of

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others' inner experiences. Jeon et al. (2024) examined the use of immersive virtual reality in empathy training, with a particular emphasis on cognitive empathy.Their study introduced the VR game *Mysterious Museum*, which aims to improve users' ability to recognize that people may interpret the same situation in varying ways. By engaging users with ambiguous visuals and 3D models, the game promotes perspective-taking—a central component of cognitive empathy. The authors further emphasize that VR's unique characteristics, like its ability to elicit a powerful sense of presence, play a significant role in its overall effectiveness in fostering both cognitive and emotional empathy. The results indicate that the impact of virtual reality on empathy is strongly connected to the structure and goals of the VR intervention. For example, the research by Cummings et al. and Jeon et al. illustrates that VR scenarios designed with perspective-taking activities—like immersive stories or interactive games—can substantially improve cognitive empathy. In contrast, Bacca-Acosta et al. (2023) employed a VR experience that may not have been explicitly tailored to target cognitive empathy, potentially accounting for the absence of significant effects in that dimension (Cummings et al., 2022; Jeon et al., 2024).

Taken together, these studies provide complementary insights into how VR affects different facets of empathy. While affective empathy appears to benefit consistently from immersive VR environments, the development of cognitive empathy seems more dependent on targeted design elements and contextual alignment.

2.6. VR, Dietary Choices, and Meat Consumption

An expanding collection of research has explored the capacity of virtual reality (VR) to impact food-related choices and promote environmentally sustainable eating habits. Although these studies provide promising findings, most tend to concentrate on the general effectiveness of VR interventions without investigating the psychological

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factors—such as empathy and presence—that might underpin the observed changes in behavior and willingness.

Plechatá et al. (2022) showed that VR experiences could effectively reduce individuals' food-related environmental impacts and enhance their perceived ability and understanding of environmental issues. However, their research did not take into account psychological factors like presence and empathy, which could be essential in influencing the behavioral outcomes.

Meijers et al. (2022) employed virtual reality to promote environmentally friendly dietary decisions by presenting ecological and wellness-related information. Although the intervention had positive results, the study did not examine how users' immersive experiences or emotional involvement contributed to their willingness to change or adopt new behaviors.

On top of that, Song and Fiore (2017) proposed a structure for creating and evaluating virtual reality settings intended to encourage nutritious dietary habits.While insightful, their model did not specifically address empathy or presence as key psychological elements, despite their potential influence on user experience and decision-making.

Other research has similarly neglected the significance of empathy and presence in influencing the outcomes of virtual reality-based interventions. To illustrate, Xu et al. (2023) investigated peoples' decisions regarding food selection within virtual grocery environments using VR and Wan et al. (2022) explored the influence of visual design elements, such as color contrast, within VR environments to promote sustainable food choices. Likewise, Smit et al. (2021) explored how virtual reality might promote nutritious dietary habits among children, whereas Crofton et al. (2021) analyzed the influence of immersive virtual reality on the sensory evaluation of food items. Despite the contributions of these studies to VR-based dietary interventions, none specifically

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addressed the psychological dimensions of presence and empathy during user engagement.

Despite the significant potential of virtual reality to influence food-related choices and willingness, a key gap persists in comprehending how presence and empathy operate within this process. The current research seeks to bridge this discrepancy by examining these two psychological constructs as potential mediators that enhance the persuasive effects of VR—particularly in encouraging reduced meat consumption. By expanding upon existing research, this study seeks to offer deeper insights into how VR can more effectively shape consumer behavior and willingness by leveraging users' emotional and immersive experiences. This direction also responds to growing scholarly interest in identifying the psychological mechanisms that underpin VR's impact on food-related decision-making.

Furthermore, several studies have specifically examined the influence of virtual reality on dietary habits related to meat consumption. Anderson et al. (2017), integrated VR with traditional media strategies to explore how immersive content could influence consumer behavior and willingness regarding pork. Participants were presented with various situations—some highlighting the health advantages of pork, while others focused on moral and ecological concerns.Their findings revealed that negative depictions of pork production led to a marked decline in consumption intentions, highlighting empathy's role in motivating dietary change and showcasing VR's capacity to intensify message impact.

In addition, Fonseca and Kraus (2016) contrasted various virtual reality presentation methods, demonstrating that individuals using head-mounted displays (HMDs) exhibited more pronounced shifts in their intentions toward meat consumption than those utilizing handheld equipment. The heightened immersive experience provided by HMDs stimulated more intense emotional responses and rendered the

doi:10.6342/NTU202504615

benefits of plant-based dietary patterns more immediate and compelling, thereby enhancing participants' willingness to adjust their eating behaviors.

Herrewijn et al. (2021) explored the potential of immersive technology to enhance empathetic understanding and encourage actions aimed at reducing meat consumption, particularly when the content highlighted animal suffering. Their results demonstrated that this immersive experiences resulted in substantially enhanced empathy when contrasted with traditional video formats, with the sense of involvement playing a key role. While their research highlighted the sequential relationship—VR creating presence, which then amplified empathy—our study aims to investigate this relationship further. Specifically, we inquire whether empathy could come before and directly influence presence, thus shaping the effectiveness of VR-based interventions (Herrewijn et al., 2021).

In summary, virtual reality possesses a distinct capacity to trigger intense emotional responses by graphically depicting animal distress and the ecological consequences associated with consuming meat. This immersive quality enhances emotional engagement, increases empathetic responses, and ultimately shapes intentions, thereby raising the probability of decreased meat intake. By examining these underlying factors, the ongoing study seeks to enhance the expanding body of research through identifying the psychological mechanisms—especially the functions of empathy and immersion—that render virtual reality an effective instrument for altering eating habits and encouraging environmentally friendly food selections.

2.7. Individualistic Differences in Presence

Do all people perceive an identical degree of immersion, regardless of differing variables? Studies indicate that personal variations in perceived immersion have attracted growing interest among investigators (Sacau & Hartmann, 2008). Studies

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suggest that users may experience presence differently, which could lead to varying levels of benefit from VR, user-specific factors, such as emotional and individual traits, have been identified as significant influences on the perception of presence (Felnhofer , et al., 2012). Since presence involves both perceptual input and psychological processing, it is reasonable to infer that individuals differ in their capacity to experience presence—just as they vary in levels of empathy. Nicovich et al. (2005) suggest that a person's ability to empathize plays a crucial role in how much they perceive their presence in digitally facilitated communication environments. In the same manner , sensory sensitivity variations account for disparities in perceived presence within immersive settings (Makransky & Petersen, 2021), highlighting that even when exposed to the same virtual stimuli, users may have distinct experiences shaped by personal factors such as focus control and mental engagement. Supporting this notion, Sacau et al. (2008) demonstrated through empirical investigation that prior interest in virtual content can heighten attentional focus and improve resource allocation, ultimately amplifying the sense of presence.

Expanding on individual differences, Ling et al. (2013) explored how personality traits, cognitive style, and empathy might influence perceived presence within a VR public speaking scenario. Participants experienced both stereoscopic and non-stereoscopic versions of a virtual presentation, allowing for comparisons across immersive conditions. Interestingly, among the measured traits, only empathy showed a statistically significant correlation—with higher empathy levels predicting greater susceptibility to simulator sickness, as measured by the Simulator Sickness Questionnaire (SSQ).

Whereas previous research, such as Nicovich et al. (2005), concentrated on activities like learning to fly a light aircraft, and Ling et al. (2013) prioritized public speaking performance, the current study provides a unique contribution by

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concentrating solely on the influence of empathy in shaping immersion within virtual experiences. Instead of focusing on task-related actions, this study seeks to examine the emotional and perceptual mechanisms connecting empathy to how individuals perceive immersion within simulated environments. Specifically, the study investigates whether varying degrees of empathy influence their experience of immersion in a VR setting centered around the “belief in eating beef. Additionally, it investigates whether an increased sense of presence mediates shifts in participants' willingness to eat meat. With this conceptual foundation, the following hypothesis is presented:

H1: Participants who are more empathic will feel more presence in virtual reality

H2: After watching VR, the higher the level of presence, the lower the future beef consumption willingness

While Nicovich et al. (2005) examined a concept aligned with Hypothesis 1 and found empirical support, their research was situated in the context of flight simulation—a task-oriented setting that emphasized functional interaction with the virtual environment. In contrast, this research examines a comparable psychological route within a different VR scenario, aiming to assess whether empathy’s effect on presence can be generalized beyond performance-based simulations to more affectively driven virtual experiences.

In addition, drawing from existing research, our study identifies two factors that mediate behavior change. Firstly, as discussed in the section "VR, Dietary Choices, and Meat Consumption," the shift in the perception of cow suffering is seen as the empathy triggered by the intervention. Secondly, referencing the section “Empathy Toward Humans and Animals,” the change in willingness to reduce beef consumption signifies

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an alteration in participants' attitudes resulting from the experimental procedure. These contributing elements are essential for understanding how the procedure affects individuals' behavioral responses to meat intake by revealing the underlying mechanisms.

H3a: **The relationship described in H2 is mediated by participants' increased anti-beef eating willingness which in turn leads to a decrease in future beef consumption willingness.**

H3b: **The relationship in H2 is mediated through establishing willingness toward cow suffering, which in turn leads to a decrease of the future beef consumption willingness.**

To strengthen our claim and validate the importance of presence, this study contrasts participants' future intentions to consume beef across three conditions: a high-presence VR group, a low-presence VR group, and a conventional video group. Given the uncertainty about the impact differences between the high-presence VR group and the video group, no specific forecast is made regarding their comparison.

Consequently, the following hypothesis is suggested:

H4: For the future beef consumption willingness after the intervention, the VR group with high presence will show a lower willingness than the VR group with low presence

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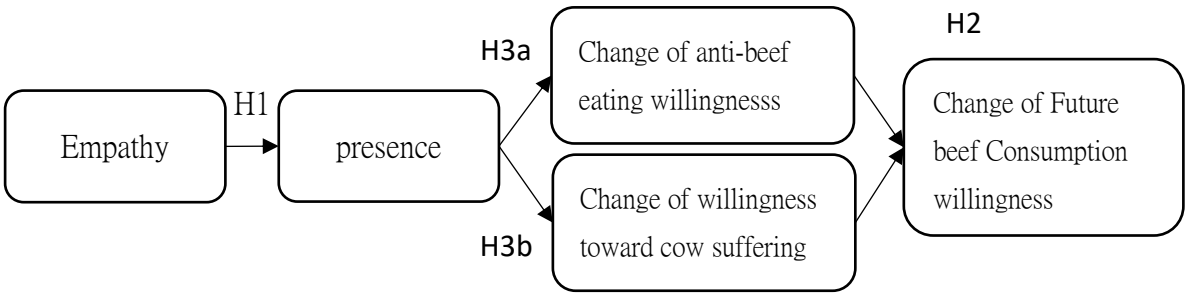

Figure 1. A Conceptual Model of the Primary Hypotheses for Empathy, Presence, and Willingness Toward Beef Consumption.

2.8. Empathy and Gender

Both common perceptions and empirical research converge on the idea that women generally exhibit greater empathy than men. Popular culture often portrays women as more attuned to understanding others' thoughts and emotions, reinforcing the notion of gender-based differences in empathy (Klein & Hodges, 2001).

According to Nicovich et al., (2005), it is widely recognized in the field of psychology that women generally show higher levels of empathy compared to men. Empirical evidence supports this view, with numerous studies showing that women consistently score higher on both self-reported and observational measures of empathy (Gault & Sabini, 2000; Macaskill et al., 2002). For instance, women tend to report greater perspective-taking and emotional responsiveness on self-report tools like the Empathizing Quotient (EQ), which evaluates attention to the needs and feelings of others (Baron-Cohen & Wheelwright, 2004). These findings suggest that females tend to be more inclined to perceive and engage with others' emotions compared to men.

Gender differences in empathy seem to develop early in life. Research involving children and adolescents has consistently shown that girls exhibit greater interpersonal sensitivity and empathy than boys (Tucker et al., 1999; Van Tilburg et al., 2002). Girls tend to be more inclined to express emotions such as sadness, hurt, or sympathy in

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response to distressing scenarios (Rose & Rudolph, 2006). These differences remain evident throughout adolescence, with girls showing stronger empathic responses to emotionally evocative situations, such as watching emotionally charged videos or engaging with stories involving distressed protagonists (Eisenberg et al., 1989). Even in experimental settings designed to minimize gender bias, girls have been found to exhibit greater facial expressions of empathy than boys (Roberts & Strayer, 1996). Such findings suggest that gender differences in empathy are both robust and persistent across developmental stages.

When examining the specific components of empathy, the largest gender differences are observed in affective dimensions, such as empathic concern and emotional arousal, rather than cognitive measures of empathy (Hoffman, 1977; de Corte et al., 2007). Women generally exhibit greater sensitivity toward others' emotions and experience higher degrees of personal discomfort. in reaction to others' pain, which are fundamental components of affective empathy (Davis & Franzoi, 1991). These findings are consistent across different methodologies, further highlighting the pronounced emotional responsiveness of women compared to men. Although cognitive empathy—such as understanding another's perspective—shows smaller gender differences, women still tend to perform better in tasks requiring empathic accuracy, especially when gender roles are emphasized (Klein & Hodges, 2001).

The causes of these gender differences in empathy remain a topic of debate among researchers. Some studies suggest that these differences may stem from socialization processes that encourage women to adopt nurturing roles, leading to greater empathy-related behaviors (Michalska, Kinzler & Decety, 2013). Some propose that motivational factors, rather than innate ability, contribute significantly to women's higher empathy levels (Klein & Hodges, 2001). Regardless of the underlying mechanisms, the consensus is clear: Females typically exhibit greater empathic

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sensitivity compared to males across various contexts and measures (Toussaint & Webb, 2005; Kamas & Preston, 2021).

These results have significant consequences for comprehending gender variations in emotional and social behavior. Women's higher levels of empathy are often linked to their greater prosocial behavior and ability to build and maintain social relationships (Christov-Moore et al., 2014). This may also explain why women are often perceived as more cooperative and attentive to others' needs, traits that are critical in caregiving and interpersonal roles. Simultaneously, these gender disparities emphasize the necessity for more detailed studies to investigate the interaction between biological, social, and cultural influences that shape empathy. Ultimately, understanding these dynamics can help inform interventions and educational practices that foster empathy across genders. The following is our hypothesis concerning the relationship between gender and empathy.

H5: Within the VR group, there are significant gender differences in empathy.

2.9. Presence and Gender

Research consistently highlights gender-based differences in levels of presence across various contexts. Felnhofer et al. (2014, 2012) highlight that male participants generally report greater levels of spatial presence. Particularly, in collaborative virtual environments, men, regardless of age, experienced enhanced spatial presence (Felnhofer et al., 2014). In the same vein, during speech delivery tasks to either a simulated or hypothetical audience, men reported a stronger feeling of presence (Felnhofer et al., 2012). Lachlan and Krcmar (2011), in their investigation of video game-related presence, found that men showed greater sensory presence. On the other hand, some studies have revealed opposing results. Botta and Bracken (2004) found that females experienced a stronger sense of presence in specific situations. Further

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research investigating gender as an influencing variable in presence has uncovered nuanced patterns. Nicovich et al. (2005) found that men reported higher presence levels during active, interactive tasks, such as operating a flight simulator, while women exhibited stronger presence in passive, non-interactive contexts. Similarly, Slater et al. (1998) noted that men demonstrated higher presence during complex tasks requiring memory and attention to virtual cues, whereas women showed stronger presence in simpler tasks. These gender differences extend to specific dimensions of presence, including perceived realism, spatial presence, involvement, and control. The following is our hypothesis concerning the relationship between gender and presence.

H6: Within the VR group, there are significant gender differences in presence.

2.10. Gender Differences in Meat Consumption

A substantial body of research has uncovered significant gender differences in interactions between humans and their environments, as well as with animals. Women, in general, demonstrate a higher level of care for the welfare of animals and tend to participate more actively in initiatives aimed at safeguarding animals and the environment. They also demonstrate higher environmental consciousness, stronger empathy for animal distress, and more positive attitudes toward animals. Consequently, women are more inclined to take actions that promote animal welfare (Graça et al., 2018; Mertens et al., 2020).

On the contrary, men are more likely to perceive eating meat as an enjoyable activity, downplay concerns about animal suffering, and view humans as hierarchically superior to animals. Males tend to perceive meat consumption as a fundamental element of human behavior.

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Additionally, they are more inclined to justify eating meat through religious beliefs about the human-animal relationship or by citing health-related reasons (Mertens et al., 2020; Rothgerber, 2013). These gendered differences in willingness toward animals and meat consumption are significant, as Kellert and Berry (1987) emphasized, with gender being one of the most influential demographic factors shaping societal willingness toward animals.

Further, research by Keller and Siegrist (2015) highlighted personality and behavioral distinctions related to dietary choices. They discovered that females displayed greater levels of neuroticism and openness to experience compared to men. Women also showed a greater willingness for emotional and restrained eating, consuming more fruits, vegetables, and salads while avoiding meat and sugar-sweetened beverages more frequently than men.

These patterns are consistent across diverse cultural contexts. Studies from various countries indicate that women consistently consume less meat than men. For instance, Allen et al. (2000) and Goldberg and Stycker (2002) documented this trend in the United States, while Kubberød et al. (2002) observed similar findings in Norway. Research by Santos and Booth (1996) confirmed these patterns in Britain, and broader European studies, such as those by Prättälä et al. (2006), further corroborate this trend, as extensively reviewed by Rothgerber (2012). These findings demonstrate the universality of gender differences in dietary habits.

Moreover, gender differences in dietary beliefs reflect traditional male-female roles. For example, in Baltic countries, men consume more meat than women and regard it as essential for health. These differences are not limited to the Baltic region; similar patterns have been observed in Finland (Prättälä et al., 2007). Women's lower meat consumption is often associated with concerns about health, ethical considerations, and negative feelings toward meat, including its taste, smell, and appearance.

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Together, these studies paint a clear picture of how gender significantly influences dietary behaviors, willingness toward animals, and broader health-related practices. Women's dietary habits and beliefs are closely tied to their higher concern for animal welfare and environmental protection, while men's meat consumption is often linked to traditional ideas of masculinity and social expectations. These findings underscore the significance of recognizing gender as a crucial element in understanding eating habits and their wider social consequences. Building on the preceding analysis, the following hypotheses are suggested.

H7a: Within the VR group, there are significant gender differences in the changes in anti-beef-eating willingness.

H7b: Within the VR group, there are significant gender differences in the changes in willingness toward the suffering of cows.

H8: Within the VR group, there are significant gender differences in the changes in future beef consumption willingness.

Finally, the study wanted to examine the predictive outcomes of different variables, so I formulated the following hypotheses.

A substantial body of research has identified gender as a salient determinant of dietary behavior, with women consistently exhibiting lower levels of meat consumption and heightened sensitivity toward animal welfare issues (Rothgerber, 2013). Empathy is acknowledged as an essential psychological factor driving these behaviors, as individuals with higher empathic ability are more inclined to participate in pro-animal and pro-environmental actions (Mertens & Siegrist, 2021).

The combination of gender and empathy provides a robust framework to understand variations in beef consumption willingness, particularly in contexts where

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immersive interventions like VR aim to evoke emotional responses. Building on the preceding discussion, the study proposes the following hypothesis.

H9: Gender and empathy predicting changes in future beef consumption Willingness.

Age is another demographic factor that significantly influences dietary behaviors. Older individuals are often more health-conscious and exhibit dietary patterns that align with reduced meat consumption compared to younger individuals (Goldberg & Strycker, 2002). When combined with gender and empathy, age can further explain differences in responses to interventions targeting meat consumption reduction. Individuals identifying as female and those exhibiting higher levels of empathy are generally more inclined to reduce meat consumption. Additionally, age may function as a moderating variable, with older individuals potentially adjusting their dietary willingness due to heightened health consciousness or evolving ethical orientations. Based on the foregoing conceptual rationale, the present study proposes the following hypotheses.

H10: Gender, age, and empathy predicting changes in future beef consumption Willingness.

Empathy is directly linked to willingness about animal welfare, with individuals high in empathy demonstrating greater concern for the suffering of animals (Knight et al., 2004). Gender and age also influence these inclinations, as women and older individuals are typically more responsive to moral and emotional concerns related to animal welfare (Paul, 2000). These variables collectively provide a comprehensive explanation for changes in willingness toward the suffering of cows, particularly in scenarios designed to elicit empathy for animals and highlight ethical considerations

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related to meat consumption. Based on the discussion above, the study proposes the following hypothesis.

H11: Gender, age, and empathy predicting changes in willingness toward the suffering of cows.

2.11. Supplementary Studies

2.11.1. Decision to Use Integrated Empathy Scale

In this research, a comprehensive empathy scale was employed instead of evaluating cognitive and emotional empathy as distinct components. This methodological decision was guided by several important considerations.

A primary rationale for this method is that employing separate scales for cognitive and emotional empathy complicates the assessment process and imposes a higher cognitive load on participants. Given that such scales typically involve numerous items, they may contribute to participant fatigue, potentially compromising data quality and reliability. Employing a unified empathy scale streamlines the assessment process, reduces cognitive demands, and enhances participant engagement (De Leeuw, 2005).

Another crucial factor is that the main aim of the current study is to analyze the overall impacts of virtual reality on empathy, rather than to separate its individual elements. As such, utilizing a unified scale allows for the measurement of empathy as a comprehensive construct, which is more in line with the study's objectives. Moreover, a composite empathy score simplifies data analysis by facilitating direct statistical associations between VR experiences and overall empathic change. This approach improves analytical efficiency by eliminating the need to separately interpret cognitive and affective components, and enhances model robustness by minimizing variance within the dataset (Batson & Ahmad, 2009).

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Furthermore, cognitive and emotional empathy are frequently experienced together in real-world scenarios and are challenging to disentangle. Within immersive VR environments, participants may simultaneously establish emotional connections with characters while also developing an intellectual comprehension of their viewpoints. Consequently, approaching empathy as a cohesive construct provides a more accurate representation of users' empathic responses in VR contexts and prevents potential issues arising from artificially segmenting its components.

The choice to utilize a comprehensive empathy scale is additionally reinforced by past studies. Numerous studies suggest that distinctions involving emotional and cognitive empathy become less apparent in particular situations, especially in highly immersive settings.

As such, combining both dimensions into a unified empathy construct provides a more thorough understanding of participants' affective and cognitive responses during VR experiences (Cuff et al., 2016).

Another key point to examine is how presence and empathy are related. A significant body of research indicates that an enhanced perception of immersion within virtual environments can stimulate higher empathy, which in turn influences individuals' attitudes and actions—such as raising the probability of participating in prosocial activities like signing petitions or adopting stances that support human rights.

Various studies emphasize this pattern. Herrera et al. (2018) demonstrated that individuals who engaged with immersive media were considerably more inclined to endorse initiatives addressing the presented issue. Similarly, Bujić et al. (2020) investigated how immersive journalism could shape human rights attitudes. Their findings supported the hypothesis that the act of "stepping into another’s shoes" within VR contexts can trigger empathetic responses, thereby fostering favorable shifts in willingness. Ahn et al. (2013) utilized a VR simulation in which participants

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experienced life as a colorblind person. Results showed that this intervention significantly enhanced empathy and subsequent real-life prosocial behaviors, as participants were more willing to offer help, illustrating the power of shared virtual experiences to heighten empathic engagement.

While these prominent studies suggest that presence can act as a trigger for empathy, promoting behavioral change, they frequently neglect the possibility that empathy itself may be a pre-existing individual trait. In contrast, the current study aims to investigate a different perspective: that empathy, as a consistent dispositional characteristic, might actually precede and enhance the feeling of presence within virtual reality environments.

As stated previously, findings from Nicovich et al. (2005) provide strong evidence supporting the idea that variations in empathy are an important factor in shaping users' perception of presence in digital communication environments. Correspondingly, Ling et al. (2013) conducted an experiment investigating how personal characteristics—such as empathy—affect perceived presence in virtual settings. Participants experienced both non-stereoscopic and stereoscopic public speaking simulations, allowing the researchers to compare their reactions across different conditions. The findings revealed that empathy was strongly associated with results on the Simulator Sickness Questionnaire (SSQ), indicating that empathic tendencies could impact VR involvement on both psychological and physical levels.

Although VR is commonly employed as a means to promote empathy, the evidence regarding its effectiveness remains inconclusive. Research indicates that virtual reality effectively enhances emotional empathy, while its influence on cognitive empathy remains more limited (Martingano et al., 2021). Technical limitations further complicate this dynamic. When the visual fidelity of virtual characters—such as facial expressions or movement—is low, users may experience a sense of detachment, thereby

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diminishing emotional resonance (Skarbez et al., 2017). Several scholars argue that VR's inability to fully replicate real-world interpersonal dynamics restricts its capacity to elicit enduring affective responses (Kampmann et al., 2016). In some situations, users have responded to immersive VR content with emotional disengagement or apathy, especially when confronted with excessively intense or disturbing scenarios (Neys & Jansz, 2010). The absence of genuine emotional signals also diminishes VR's capacity to foster empathy (Schutte & Stilinović, 2017).

As a whole, these studies suggest that factors such as hardware constraints, immersion depth, and character realism contribute to the inconsistent outcomes observed in VR-based empathy interventions (Kampmann et al., 2016; Martingano et al., 2021). To tackle these issues, the research has created a deeply immersive VR environment where participants directly observe the suffering of animals. This approach seeks to amplify emotional involvement by enhancing realism and presence, thus provoking an immediate emotional response. Although previous studies have emphasized the constraints of VR in fostering empathy, this study offers a novel lens through which to reassess VR's capacity to shape users' willingness—particularly regarding meat consumption.

Drawing from these insights, this study posits that empathy is not merely a consequence of presence in VR but may serve as its antecedent. This proposition challenges the prevailing assumption that presence fosters empathy and instead explores the reverse causal relationship—wherein pre-existing empathic capacity enhances perceived presence during immersive experiences.

Although the decision to assess empathy as a unified construct has been justified earlier, it is worth noting that the debate between integrated and differentiated empathy measurement remains open to further exploration. As such, the following section provides a more comprehensive rationale for adopting a holistic approach, while also

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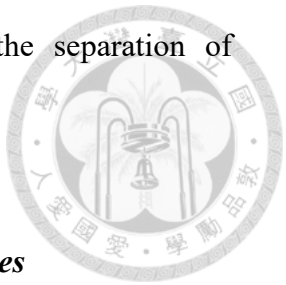
acknowledging the potential trade-offs involved in foregoing the separation of cognitive and affective empathy dimensions.



2.11.2. Comparative Analysis of Empathy Measurement Approaches

When deciding how to evaluate cognitive and emotional empathy, either independently or as an integrated construct, it is important to evaluate these approaches based on their theoretical distinctions, practicality of measurement, and relevance to virtual reality contexts. An analysis of these methods is provided below, drawing from the work of Caruso and Mayer (1998), Davis (1983), and Hogan (1969).

Evaluating cognitive and emotional empathy independently allows for clearer conceptual distinctions across these somewhat distinct frameworks. Cognitive empathy involves recognizing and interpreting another person's emotional state or perspective—similar to theory of mind—while affective empathy pertains to the emotional response elicited by others' emotional experiences. Assessing them individually offers a more thorough understanding of their specific roles and effects (Caruso & Mayer, 1998; Davis, 1983).

Hogan's empathy scale, which centers on cognitive aspects such as social functioning and role assumption, illustrates the potential limitations of single-focus assessments (Hogan, 1969).

From a practical standpoint, however, an integrated empathy scale offers methodological efficiency. Caruso and Mayer (1998) have argued that combining multiple constructs into a unified measure can alleviate participant burden and improve response quality by streamlining the data collection process. Nevertheless, this integrative strategy may obscure subtle distinctions between cognitive and affective dimensions, which can be particularly relevant when examining their specific influence on behaviors or psychological mechanisms.

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In the realm of virtual reality (VR), particularly when exploring the connection between empathy and the feeling of presence, distinguishing between empathy types may offer analytical advantages. For example, cognitive empathy may be more closely tied to narrative engagement and role enactment, while affective empathy may amplify emotional immersion. Thus, separate measurement could yield insights into how each dimension contributes to users' VR experiences.

Despite these advantages, many recent VR studies favor a unified measurement approach, particularly when the goal is to evaluate generalized empathic responses rather than isolate specific mechanisms. This methodological trend supports more streamlined experimental designs. Van Loon et al. (2018) utilized a single metric for cognitive empathy to demonstrate its relationship to media-induced perspective-taking, suggesting that a holistic metric can still yield valid insights.

Shin (2018) similarly found that immersive VR scenarios—especially those featuring emotionally intense content—can elicit robust empathic responses, thus supporting the use of integrated empathy measures in VR settings. Likewise, Hamilton-Giachritsis et al. (2018) used a unified empathy scale to assess maternal empathy after placing participants in the perspective of a child within VR. The unified scale proved effective in capturing both cognitive and emotional reactions, underscoring its suitability for VR-based empathy studies.

Considering the suggestion to explore the differences between separate and combined measurement approaches, investigations of this nature could offer insightful viewpoints on empathy evaluation and its implementation in immersive settings. Alternatively, if the objective is to examine the distinct roles of cognitive and emotional empathy within specific scenarios, employing individual measures may yield enhanced analytical precision.

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While the combined empathy scale serves as a practical middle ground between measurement efficiency and conceptual scope—especially in complex contexts like VR—it may not be optimal for studies aiming to isolate and compare the effects of each empathy dimension. In those instances, distinct measurement approaches are better suited for capturing detailed interactions and varying impacts.

In sum, although integrated empathy assessments are increasingly favored in VR-based research for their ability to provide a comprehensive view of users' emotional and cognitive engagement, selecting between integrated and separate measurement approaches should ultimately be guided by the specific goals and analytical needs of the research. These methodological choices contribute meaningfully to advancing our understanding of how VR can promote socially constructive behaviors.

2.11.3. Emotional Biases and Meat Consumption

Within the field of consumer behavior, the influence of emotional bias on purchasing decisions remains a substantial yet underexplored topic. While it is generally assumed that emotional bias influences how consumers make choices, there is still a scarcity of empirical studies that directly investigate this phenomenon. While certain studies include the term "emotional bias" in their titles, they often fail to define or operationalize the concept clearly within their main texts. Instead, these studies frequently refer to related but distinct terms such as "emotional stimuli," "emotional components," or "emotional lability," thereby obscuring the construct of emotional bias. For instance, Murphy et al. (1999) referenced "emotional stimuli" in the context of emotional responses but did not engage in a substantive discussion of emotional bias as a distinct psychological construct.

Magai et al. (2000) examined how adult attachment patterns influence emotional biases but did not clearly define emotional bias within their study. Emotional reactions

doi:10.6342/NTU202504615

were treated as independent factors without presenting a cohesive conceptual framework (Magai et al., 2000). Similarly, Novianggie and Asandimitra (2019) investigated how psychological tendencies and perceptual distortions shape investment decisions; however, their analysis did not delineate the distinctions among these types of biases, nor did it provide an explicit definition of emotional bias (Novianggie & Asandimitra, 2019). These examples reflect a broader issue in the literature: despite frequent references to emotional bias, the construct is often left underdefined and insufficiently theorized.

Although research on this topic is limited, our review of the existing literature revealed two studies—Yuan et al. (2019) and Pompian (2012)—that explore emotional bias in a systematic way. Yuan et al. (2019), based on comprehensive research, revealed that affective predispositions is shaped by factors such as the type of stimulus, level of arousal, and task structure. On the other hand, Pompian (2012) looked at how specific emotional biases affect financial decision-making. Building on these two seminal studies, the current research extends their findings to propose how emotional bias could influence decisions related to meat consumption. A thorough analysis of these studies follows.

2.11.4. Negative Bias and Positive Bias

Yuan et al. (2019) suggest that emotional bias serves as a fundamental evolutionary adaptation in shaping human responses to emotional triggers.These biases have been essential for survival, motivating us to seek rewards and avoid dangers, thereby improving our ability to adapt to our surroundings (Yuan et al., 2019). While emotional stimuli are typically categorized as positive or negative (Lang et al., 1998), human responses to them often differ significantly because of the varying survival significance of every emotional response.

doi:10.6342/NTU202504615

Emotional bias generally appears in two main forms: negative bias and positive bias. Negative bias refers to the inclination to react more strongly to negative stimuli than to positive ones (Carretié et al., 2001).This enhanced sensitivity significantly influences cognition, attention, and decision-making by triggering stronger physiological responses and drawing heightened attention. Functioning as an adaptive mechanism, negative bias enables rapid detection and reaction to threats or dangers, thereby supporting harm avoidance and survival.

Conversely, positive bias involves a greater responsiveness to positive stimuli, particularly in safe or low-arousal contexts (Carretié et al., 2008). In such environments, humans are more inclined to focus on rewarding stimuli, encouraging exploration, learning, and prosocial behaviors. Positive bias fosters social bonding, resource acquisition, and personal development—contributing to long-term well-being and adaptive functioning (Yuan et al., 2019).

These tendencies are believed to originate from distinct psychological mechanisms aimed at promoting survival. Defensive bias corresponds to protective mechanisms that trigger avoidance behaviors and initiate stress responses.This system increases alertness and sharpens focus, allowing individuals to react efficiently to immediate dangers (Yuan et al., 2019).

Positive bias is related to the reward-oriented motivational system, which promotes approach-oriented behaviors aimed at pursuing rewards. This system underlies actions such as seeking nourishment, cultivating relationships, and exploring new environments. By promoting curiosity and goal-directed behavior, the appetitive system facilitates adaptation and growth in non-threatening contexts (Yuan et al., 2019).

Emotional biases also influence individuals' tendencies toward dietary choices in daily life. Negative bias can amplify attention to the detrimental consequences of consuming animal products, such as environmental degradation and animal suffering.

doi:10.6342/NTU202504615

These adverse associations can trigger strong emotional reactions, prompting individuals to reduce or eliminate consumption to avoid these negative outcomes. Conversely, positive bias emphasizes the appealing and beneficial aspects of consumption, such as taste and perceived advantages.

In the absence of immediate threats, positive bias may reinforce meat-eating behavior—particularly in social or celebratory contexts, where meat is often symbolically linked to abundance, festivity, and status (Cacioppo et al., 1999; Taylor, 1991).

Enhancing awareness of these biases can contribute to developing more adaptive eating strategies—approaches that enable people to reconcile enjoyment with ethical, ecological, and personal considerations. To sum up, emotional biases—such as negative and positive biases—serve a vital function in human decision-making by steering adaptive reactions to various stimuli. These biases underpin psychological mechanisms that ensure adaptation and resilience, enabling individuals to navigate complex environments.

2.11.5. Pompian's Emotional Biases

Pompian (2012) indicated numerous emotional biases that consistently impact how people make decisions. These biases are particularly relevant to consumer behavior and can provide insights into specific patterns in food preferences. Endowment bias occurs as individuals attribute disproportionate worth to items they already own. When applied to eating habits, this bias may lead individuals to overestimate the worth of their existing dietary preferences—such as a fondness for meat—resulting in psychological resistance to altering their eating habits. This cognitive attachment to familiar eating practices can hinder the adoption of alternative behaviors, such as reducing meat intake or embracing plant-based diets.

doi:10.6342/NTU202504615

Self-control bias reflects a tendency to prioritize immediate gratification over long-term objectives. Within the context of meat consumption, this bias is evident in the challenges individuals encounter when trying to resist the sensory pleasure and practicality of meat-based dishes. Although there is widespread awareness of the long-term health and environmental advantages linked to lower meat consumption, individuals often struggle to override short-term desires, resulting in behaviors that are inconsistent with their stated values or intentions.

Regret aversion bias refers to the willingness to avoid actions that might result in future regret (Pompian, 2012). In the realm of dietary behaviors, individuals may be concerned about possible dissatisfaction after modifying their eating patterns, which hinders them from modifying their regular meat intake or considering alternative dietary choices. This hesitation, often arising from a fear of regret, serves as a major psychological obstacle to embracing more sustainable dietary habits.

Status quo bias denotes a tendency to favor existing behaviors or conditions over adopting new approaches, primarily due to the uncertainty and perceived risks linked to alternative options (Pompian, 2012). With regard to meat consumption, this bias reinforces individuals' adherence to established eating patterns, even when presented with more sustainable and health-conscious alternatives. Since meat has been normalized as part of daily life, efforts to promote plant-based diets often encounter resistance, grounded in the belief that longstanding habits need not be questioned. Status quo bias leads to behavioral stagnation, causing individuals to be less inclined to embrace alternatives—even when those alternatives are clearly more beneficial. Addressing this bias may require incremental strategies, such as behavioral nudges or stepwise interventions, that facilitate gradual transition without triggering psychological resistance.

doi:10.6342/NTU202504615

These emotional biases present notable obstacles to changing consumer behavior toward healthier and more environmentally friendly eating habits. One possible outcome is that these biases may hinder people from deeply interacting with immersive experiences. such as virtual reality (VR) films, thus reducing the impact of intervention strategies. Contrarily, people with greater empathy may be less prone to these emotional biases. Their greater openness and emotional responsiveness may enhance immersion in VR environments, leading to more pronounced behavioral and attitudinal shifts following the intervention.

2.11.6. Culture and Meat Consumption

Meat consumption extends beyond a mere nutritional decision; it is deeply intertwined with the cultural, social, and financial frameworks of various nations. Although individual preferences may appear to guide dietary behaviors, they are in fact heavily shaped by overarching cultural norms and collective values. To effectively address global issues such as sustainability and public health, it is essential to investigate how cultural contexts shape meat-eating behaviors. Drawing on case studies from Europe and East Asia, this section explores the sociocultural forces that potentially influence patterns of meat consumption across different regions.

In Denmark, dietary practices surrounding meat are strongly influenced by social norms, where meat is commonly linked to affluence and a high standard of living (Hielkema & Lund, 2021). For many Danish citizens, eating meat signifies wealth and social prestige, rendering it a prominent feature of the national diet. While public health concerns have prompted some to reconsider their meat intake, such intentions are often outweighed by deep-seated social expectations (Hielkema & Lund, 2021).

In Sweden, cultural identity and the desire for social inclusion serve as key drivers of dietary behavior. As noted by Collier et al. (2021), meat consumption in Sweden

doi:10.6342/NTU202504615

exhibits inconsistency, in part due to public doubt toward alternative protein sources. Swedish cultural traditions often reinforce established eating habits, thereby creating obstacles for efforts aimed at reducing meat intake (Collier et al., 2021).

Similarly, in Scotland, eating meat is embedded in cultural traditions and social practices. According to Macdiarmid, Douglas, and Campbell (2016), for a significant portion of the Scottish population, meat symbolizes not only nourishment but also a symbol of lifestyle, pleasure, and social bonding. Such associations with cultural heritage and interpersonal relationships make meat reduction campaigns particularly challenging in contexts where community and tradition are prioritized.

In contrast to European countries, East Asia has experienced considerable transformation in meat consumption patterns, driven primarily by rapid economic growth and global cultural exchange. Historically, dietary patterns in East Asia were predominantly based on staple crops and plant-based foods, with spiritual customs and societal norms restricting animal consumption. Nevertheless, as wealth has grown and Western lifestyles have become more prevalent, the importance of meat has risen, making it a common part of daily meals (Nam et al., 2010).

In China, economic growth has reshaped meat consumption. What was once used occasionally as a seasoning, meat is now seen as an essential part of everyday meals and a symbol of wealth (Nam et al., 2010). In Korea, culinary practices reflect Mongolian cultural influences, where meat is central to diverse cooking methods and prominently featured in communal dining, especially during family-oriented events. Japan, on the other hand, has witnessed a clear trend toward Western dietary preferences, exemplified by the increasing adoption of Western-style meat dishes and eating habits (Chern et al., 2003; Kim et al., 2009).

Overall, these examples illustrate that cultural and societal structures play a crucial role in shaping both individuals' views on meat consumption and the effectiveness of

doi:10.6342/NTU202504615

efforts to modify behavior. In Europe, long-standing traditions and collective identity often impede reductions in meat intake. In East Asia, economic modernization and Western influence intersect with local values, resulting in varied responses to sustainability-oriented dietary interventions.

To advance the effectiveness of policies and interventions targeting meat consumption reduction, it is crucial to account for the moderating influence of cultural dynamics. Strategies should be context-sensitive and adapted to specific cultural backgrounds and social groups to foster more meaningful shifts in willingness and behavior. Although this study does not explicitly focus on societal influences, the discussions provided offer valuable contextual insights that improve the overall comprehension of the connection between behavioral intentions and actual practices related to meat consumption.

doi:10.6342/NTU202504615

CHAPTER THREE

METHOD AND RESULTS

3.1. Research Design

This research utilized an experimental setup with two groups: a virtual reality (VR) group and a control group using conventional video. Before the intervention, participants filled out a series of surveys evaluating their past experiences with virtual settings, their views on cow suffering, and their meat-eating habits.

For the VR condition, the experiment utilized the Meta Quest 3 headset, dual handheld controllers, and a PC equipped with an ASUS Dual RTX 4070 O12G graphics card. The VR environment was developed using Unreal Engine and conducted in a 2.5 x 2.5 meter laboratory space. Participants could freely rotate their heads to change their field of view, and they used both handheld controllers to control their virtual hands and bodily movements.

The VR experience portrayed a simulated farm setting, featuring two cows, one of which was injured and lying on a table. The duration of the experience was about four minutes. Subjects could interact with the environment and were notified that one of the cows was injured. Once inside the VR scenario, they were directed to engage with the surroundings, such as by touching the cows' heads, which prompted audible reactions. Throughout the exploration, a pre-recorded narrative provided contextual information about the life of a cow. Eventually, participants were directed toward the injured cow, and the narrative conveyed that the animal was in pain, immersing participants in a first-person perspective of the scene. After completing the VR condition, participants had to complete the same set of questionnaires once more.

In the video condition, participants watched a video on a 22-inch LCD screen with a resolution of 1920x1080 pixels. The video replicated the visual and auditory

doi:10.6342/NTU202504615

components of the VR scenario, featuring the identical narration describing the life of a cow. Notwithstanding, those in this condition had no ability to control the experience—they could not change the playback or viewpoint, and the experience remained fully non-interactive. While the video was presented from a first-person perspective, participants did not see any depiction of themselves within the footage.

Below are representative screenshots illustrating the VR environment:

Figure 2: Two virtual cows in a virtual pasture, along with a virtual hand.

Figure 3: An injured cow that groans in pain.

The following is the narrated content introducing the life cycle of cattle through Virtual Reality and Video.

doi:10.6342/NTU202504615

Did you know? Most beef cattle live only a short 18 months, or 540 days, before being sent to the slaughterhouse and eventually appearing on people's dining tables. Today, let's take a closer look at the life of beef cattle to understand the rearing process.

Nowadays, many cattle farmers raise high-quality breeds. As a result, a considerable number of calves are not born naturally but require assisted delivery, sometimes even involving tractors to help with the process. In the first three days after birth, calves are relatively weak and need careful protection from the cold. By the 10th day, they can begin eating small amounts of concentrated feed in addition to drinking milk. By the 60th day, as the calves grow larger, their nutritional needs increase, requiring additional feed and hay to support their growth.

At around 150–180 days, the calves are weaned. By 210 days, they are classified as "fattening cattle." After another month, these cattle adjust fully to their routine, consuming large amounts of concentrated feed and hay daily. However, by 300 days, prolonged overfeeding begins to strain their stomachs, so farmers often add digestive powders and probiotics to improve their digestion. At 400 days, the cattle's skeletal growth stabilizes, and they begin gaining significant muscle mass, prompting farmers to provide even larger quantities of feed to accelerate fattening.

By 480 days, after a period of intensive fattening, the cattle's digestive systems often show signs of imbalance, and symptoms of systemic acidosis become evident. Unfortunately, most cattle cannot receive effective treatment and rely only on painkillers for relief. By 510 days, those with poor digestion or minimal weight gain are sent to the slaughterhouse. The healthier ones, which show ideal weight gain, are allowed to live a bit longer.

At 540 days, the end of their life cycle arrives. Although beef cattle can still gain weight, the rate of weight gain slows significantly. This marks the final destination of

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their lives—the slaughterhouse. The cattle you see lying weakly on the ground will soon be transported there, where they will be processed into beef.

3.2. Participants

This research was reviewed and approved by the Research Ethics Committee of National Taiwan University, receiving full board approval on July 18, 2023 (Approval No.: NTU-REC 202305HM005).

Participant recruitment was primarily conducted through social networking platforms. As compensation for their contribution, participants got a monetary incentive. The main aim of this study was to delve into how VR and empathy affect willingness regarding meat consumption. To align with this objective, only non-vegetarian individuals were included in the sample, ensuring that baseline dietary preferences would not confound the results. Individuals who adhered to vegetarian diets were excluded.

Furthermore, to reduce the likelihood of negative physical responses that could affect data integrity, people who had previously encountered dizziness, nausea, or other discomforts while using VR equipment were excluded from the study. This exclusion criterion was implemented to ensure participants could engage fully in the immersive VR experience without interruption or harm.

To establish the ideal sample size for this study, a power analysis was performed using G*Power. Specifically, this analysis was performed in relation to Hypothesis 4, which involves a one-way ANOVA comparing three groups. Assuming a statistical power of 0.80, an alpha level of 0.05, and an expected effect size ranging from medium ($f = 0.25$) to large ($f = 0.40$), the required sample size was estimated to be between 66 and 159 participants.

doi:10.6342/NTU202504615

A total of 142 individuals completed the study (50.00% female; average age = 25.22, SD = 8.18). Among them, 77 participants were allocated to the VR condition, while 65 were placed in the video condition. Based on participants' self-reported levels of presence, the VR group was further divided into two subgroups: 44 participants in the high-presence group and 33 in the low-presence group.

To assess potential group differences in demographic characteristics, a chi-square test and one-way ANOVA were conducted. Results indicated no significant differences in gender distribution across the three groups ($\chi^2(2) = 0.137$, $p = 0.91$) or in age ($F(2, 139) = 2.499$, $p = 0.082$). These findings suggest that, despite the absence of demographic constraints during recruitment, group equivalence was maintained, minimizing potential confounding effects.

3.3. Measurement

In this study, participants are randomly allocated to one of two experimental conditions: a Virtual Reality (VR) group or a video group. Before the intervention, they complete several questionnaires, including demographic information, a revised version of the Basic Empathy Scale, as well as items assessing their beef consumption habits, willingness to consume beef, and willingness to consider cow suffering. Measures related to willingness toward beef consumption and cow suffering are collected both before and after the experimental exposure.

Empathy was evaluated using the updated form of the Basic Empathy Scale (Chen & Chen, 2021), which includes items such as “My friends’ emotions don’t affect me much,” “After spending time with a friend who is upset, I usually feel upset too,” and “I easily become absorbed in other people’s emotions.” The instrument comprises 20 items rated on a 7-point Likert scale, ranging from 1 (Strongly disagree) to 7 (Strongly agree). For their willingness to consume beef, participants will answer a set of questions

doi:10.6342/NTU202504615

at different stages of the experiment. Before the experiment, they will be asked to estimate their past beef consumption by answering the following question: In the past week (7 days), how often did you consume foods or dishes that included beef, such as steak, braised beef, beef noodles, or beef jerky, during your three daily meals—breakfast, lunch, and dinner? Please estimate the number of times you consumed beef-containing foods within the past week.

Before and after the experiment, participants will answer two additional questions to assess potential changes in their willingness to consume beef. The first question asks: Looking ahead, in the upcoming week (7 days), how much do you want to eat foods or dishes that include beef, such as steak, braised beef, beef noodles, or beef jerky, during your three daily meals? Please estimate the number of times you expect to consume beef-containing foods in the coming week. The second question focuses on meal frequency: In the upcoming week (21 meals), how many meals do you expect to include beef or beef-based products?

By comparing responses before and after the experiment, this study aims to examine potential shifts in beef consumption willingness and assess the influence of experimental conditions on participants' dietary choices.

Regarding willingness toward beef consumption, participants will answer questions such as "It is important to minimize the amount of beef (ribs, steak, strip, beef jerky, etc.) a person consumes". Answers are measured on a 5-point scale spanning from "Strongly disagree" to "Strongly agree."

To assess participants' willingness related to cow suffering, they responded to items such as "Eating beef (e.g., ribs, steak, jerky, etc.) directly contributes to the suffering of cows" ($\alpha = 0.62$). These responses were captured on a 5-point Likert scale ranging from "Strongly disagree" to "Strongly agree."

doi:10.6342/NTU202504615

To determine whether different interactive media experiences influenced participants' perception of presence, this study utilized the Spatial Presence Questionnaire, modified from Tian et al. (2004), which shows strong internal consistency (α = 0.93).This instrument is grounded in Spatial Presence Theory and is designed as a multidimensional tool with established validity and reliability.

In particular, the study focused on the "self-location" dimension by employing the “Spatial Presence: Self-Location” (SPSL) subscale. Participants assessed their level of agreement with each statement using a 7-point Likert scale (1 = “Strongly disagree,” 7 = “Strongly agree”). Example statements provided: “I felt like I was really on the farm,” “I felt like I was part of the virtual environment,” “I felt like the objects in the scene surrounded me,” and “I felt like I was inside the environment depicted in the scene.” These questions were intended to assess the degree to which participants experienced physical immersion within the virtual environment (Tian & Robertson, 2019).

3.4. Exploratory Factor Analysis (EFA)

Exploratory Factor Analysis (EFA) was conducted to validate the construct validity of the measurement scale and to address the uncertainty regarding the dimensions reflected by the different items. Parallel analysis suggested the extraction of three factors. As each item is an ordinal variable, polychoric correlations were utilized for the analysis. The factor loadings were calculated using the maximum likelihood estimation method, with oblimin rotation applied. The results indicated good model fit, with TLI = 0.969 and RMSEA = 0.057, demonstrating that the model adequately explains the data.

To further confirm the number of factors to retain, a scree plot was generated based on the eigenvalues of the variables. As shown in Figure 1, the plot reveals a sharp decline after the first three factors, with the eigenvalues leveling off from the fourth

doi:10.6342/NTU202504615

factor onward. This result, combined with parallel analysis, supports the retention of three factors. Each factor aligns with distinct constructs, namely *Cowssuffer*, *BeefCons*, and *Futurebeef*. The high factor loadings (above 0.5) for each corresponding construct further confirm the validity of the scale and its subscales.

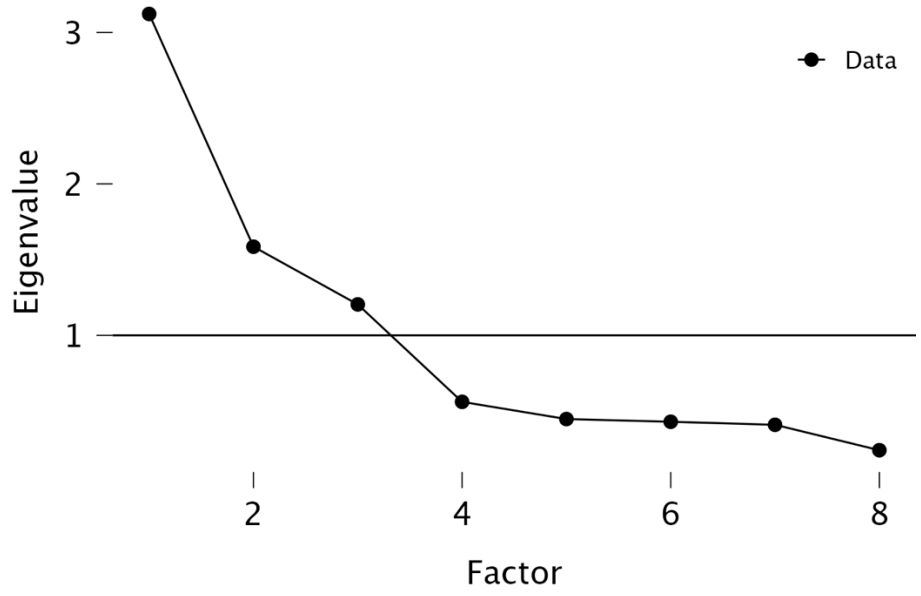

Figure 4. Scree Plot of Exploratory Factor Analysis

Factor Loadings and Structural Characteristics

The extracted factors exhibited clear structural characteristics, as all variable loadings exceeded 0.5, indicating strong associations with their corresponding factors. Specifically, the first factor, CowSuffer (willingness toward cow suffering), includes T0_CowSuffer1, T0_CowSuffer2, and T0_CowSuffer3, reflecting participants' willingness toward the suffering of cows. The second factor, BeefCons (willingness toward beef consumption), includes T0_BeefCons1 and T0_BeefCons2, which measure participants' willingness toward beef consumption. The third factor, FutureBeef (future beef consumption willingness), includes T0_Future_Beef1 and T0_Future_Beef2, representing participants' plans to reduce beef consumption in the future.

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Table 2. *Factor Loadings Matrix from Exploratory Factor Analysis*

	Factor 1	Factor 2	Factor 3	Uniqueness
T0_CowsSuffer3	0.854			0.276
T0_CowsSuffer1	0.721			0.382
T0_CowsSuffer2	0.712			0.388
T0_future_beef2		0.993		0.005
T0_future_beef1		0.697		0.464
T0_BeefCons3			0.731	0.309
T0_BeefCons2R			-0.695	0.447
T0_BeefCons1			0.546	0.407

Note. Applied rotation method is oblimin.

Factor Correlations

The factor correlation matrix presented in Table 2 shows the relationships between the three extracted factors. The results reveal that the factors are conceptually distinct, with low correlation values. Factor 1 (CowSuffer) is weakly correlated with Factor 2 (BeefCons) (r = -0.167) and Factor 3 (FutureBeef) (r = 0.242). Factor 2 and Factor 3 have a negative correlation (r = -0.265).

Table 3. *Factor Correlation Matrix from Exploratory Factor Analysis*

	Factor 1	Factor 2	Factor 3
Factor 1	1.000	-0.167	0.242
Factor 2	-0.167	1.000	-0.265
Factor 3	0.242	-0.265	1.000

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3.5. Statistical Analysis

To examine the interrelationships among the study variables, a Pearson correlation analysis was first conducted, with particular attention to testing the association between empathy scores and the sense of presence in VR (H1). This preliminary analysis aimed to identify the direction and magnitude of correlations, thereby addressing potential concerns regarding reverse causality.

Subsequently, a mediation analysis was employed to assess whether the level of presence in the VR environment influences participants' future willingness to consume beef through two proposed mediators: willingness toward beef consumption and concern for cow suffering (H2, H3a, H3b). Path analysis was used to examine both the total effect of presence on future beef consumption willingness (H2) and the indirect effect through willingness toward beef consumption (H3a). In addition, the analysis evaluated whether concern for cow suffering functioned as a significant mediator (H3b).

Support for either or both indirect pathways would provide insight into the mechanisms through which VR presence influences participants' consumption-related decisions.

To further investigate this relationship, a one-way ANOVA was conducted to assess the impact of varying levels of presence on future beef consumption willingness (H4). Based on the mean presence score, participants in the VR condition were divided into high and low presence groups. These two subgroups were then compared with the video condition group. The analysis focused on changes between pre- and post-intervention scores across the three groups. If the overall ANOVA indicated significant group differences, post hoc comparisons using the Tukey HSD test were conducted to pinpoint where the differences occurred. Prior to this, ANOVA and chi-square tests were used to ensure that the three groups were statistically equivalent in terms of gender and age, thereby minimizing potential confounding variables. This analytic approach

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allowed for a clearer interpretation of whether high VR presence resulted in greater reductions in meat consumption willingness.

All statistical tests in this study adopted a significance threshold of $p < .05$. Any statistically significant outcomes were interpreted as empirical support for the proposed hypotheses.

3.6. Results

The descriptive statistics are shown in Table 5. The empathy scale score obtained in the pretest is significantly associated with the presence in VR, $r = .335$, $p = .003$. These results support H1, rather than the opposite causal direction, as empathy was assessed before participants were exposed to the VR environment. This temporal sequencing establishes that empathy levels were determined before the VR intervention, strengthening the claim of its predictive role.

With regard to H2, H3a, and H3b, the study hypothesized that higher engagement in the VR scenario would lead to lower willingness to consume beef, heightened sensitivity to cow suffering, and ultimately a decrease in future beef consumption willingness. The mediation analysis revealed a significant total effect ($\beta = -0.196$, $p = .008$). Of the two suggested mediating pathways, only the route through Willingness Toward Beef Consumption produced a statistically significant indirect effect ($\beta = -0.033$, $p = .029$). Additionally, the direct effect of presence on Future Beef Consumption Willingness remained significant ($\beta = -0.172$, $p = .020$).

These findings suggest that participants who felt a stronger sense of presence in the VR environment were more likely to oppose beef consumption, consequently decreasing their desire to eat beef. Nevertheless, the hypothesized mediating role of Willingness Toward Cow Suffering was not supported, indicating that the decline in

doi:10.6342/NTU202504615

willingness was not primarily driven by empathy responses related to animal suffering during the VR experience.

Table 4. *Path Coefficients of Mediation Analysis*

			Estimate	Std. Error	z-value	p
CowsSuffer	→	future_beef	0.053	0.120	0.441	0.659
BeefCons	→	future_beef	-0.230	0.086	-2.664	0.008
Presence	→	future_beef	-0.172	0.074	-2.326	0.020
Presence	→	CowsSuffer	0.171	0.064	2.689	0.007
Presence	→	BeefCons	0.145	0.061	2.387	0.017

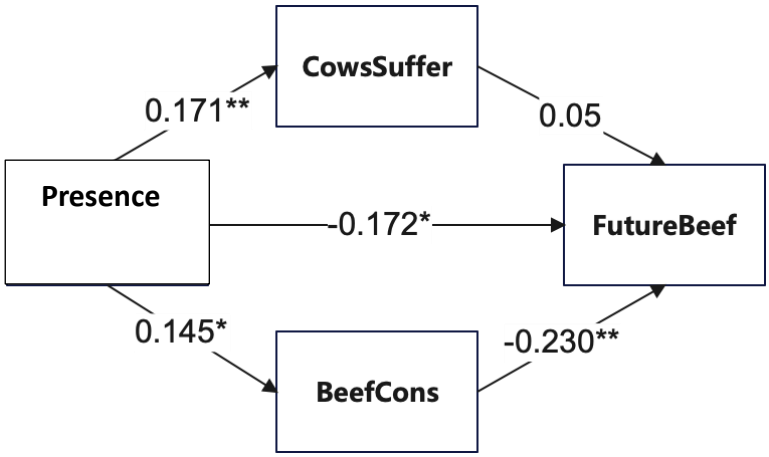

Figure 5. *The path diagram of the mediation analysis*

Table 5. *Descriptive Statistics*

Variable	Mean	SD	1	2	3	4	5	6	7	8
1. Empathy scale	3.658	0.479	—							
2. Pretest FBCT	3.162	3.170	-0.143	—						
3. Pretest ATBC	2.275	0.708	0.178*	-0.302***	—					

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Variable	Mean	SD	1	2	3	4	5	6	7	8
4. Pretest ATCS	3.272	0.877	0.165*	-0.241 **	0.422 ***	—				
5. Presence	4.974	1.558	0.335*	-0.032	0.376 ***	0.174	—			
6. Posttest FBCT	2.588	3.068	-0.144	0.902 ***	-0.371 ***	-0.314 ***	-0.166	—		
7. Posttest ATBC	2.775	0.930	0.108*	-0.212 *	0.750 ***	0.458 ***	0.426 ***	-0.311 ***	—	
8. Posttest ATCS	3.582	0.939	0.115*	-0.176 *	0.392 ***	0.701 ***	0.358 **	-0.276 ***	0.604 ***	—

Note. FBCT = Future Beef Consumption Willingness. ATBC = willingness toward beef consumption. ATCS = willingness toward cow suffering. For variables other than presence $N = 142$. For presence, $n = 77$.

* $p < .05$, ** $p < .01$, *** $p < .001$

The one-way ANOVA revealed a statistically significant difference in the change in Future Beef Consumption Willingness between the pretest and posttest across the three groups—high presence VR, low presence VR, and video—$F(2, 139) = 4.585$, $p = .012$. Subsequent post-hoc analysis using Tukey's HSD test indicated that the low presence VR group exhibited significantly smaller changes in willingness compared to both the high presence VR group and the video group ($p < .021$).

These conclusions affirm H4 by illustrating that the efficacy of the VR intervention in reducing beef consumption intentions is contingent upon the degree of presence experienced. Specifically, the behavioral impact of VR aligns with that of video-based interventions only when users perceive a heightened sense of presence in the simulated reality. Furthermore, no significant differences were observed in gender composition ($\chi^2(2) = 0.137$, $p = .91$) or age distribution ($F(2, 139) = 2.499$, $p = .082$) among the three groups, suggesting that the sample groups were demographically comparable, thereby reducing the likelihood of confounding effects.

doi:10.6342/NTU202504615

Table 6. *ANOVA Results for Future Beef Consumption Willingness Across Groups*

Cases	Sum of Squares	df	Mean Square	F	p
Group	16.645	2	8.323	4.585	0.012
Residuals	252.328	139	1.815		

Table 7. *Post Hoc Comparisons of Future Beef Consumption Willingness Across Groups*

		Mean Difference	SE	t	p_{tukey}
VR (L.P.)	VR (H.P.)	0.852	0.310	2.747	0.019
	Video	0.776	0.288	2.695	0.021
VR(H.P.)	Video	-0.076	0.263	-0.289	0.955

Note. P-value adjusted through Tukey's HSD. L.P. denotes low presence, and H.P. denotes high presence.

The results of the one-way ANOVA indicated that there were significant differences among the three groups (high-level-presence VR group, low-level-presence VR group, and video group) in changes in future beef consumption willingness, $F(2,139) = 4.585$, $p = 0.012$; see Table 6. Further Tukey HSD post hoc tests revealed specific group differences. First, the high-level-presence VR group showed significantly lower future beef consumption willingness compared to the low-level-presence VR group, with a mean difference of 0.852 (SE = 0.310), $t = 2.747$, $p = 0.019$. Second, the low-level-presence VR group had significantly higher future beef consumption willingness than the video group, with a mean difference of 0.776 (SE = 0.288), $t = 2.695$, $p = 0.021$. Lastly, there was no significant difference between the high-level-presence VR group

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and the video group, with a mean difference of −0.076 (SE = 0.263), $t = -0.289$, $p = 0.955$; see Table 7.

In summary, the results indicate that high-presence VR interventions significantly reduced future beef consumption willingness, with effects comparable to those of the video intervention. However, low-presence VR interventions showed significantly weaker effects than both the video intervention and high-presence VR interventions, indicating that the success of VR interventions is heavily influenced by the degree of presence experienced within the virtual environment.

Gender Differences

The results of the Independent Samples T-Test indicate no significant gender differences in Empathy, $t(75) = 1.489$, $p = 0.141$. This suggests that participants' levels of empathy are not influenced by their gender. Therefore, H5 is not supported.

Table 8. *T-Test Results for Gender Differences in Empathy*

	t	df	p
Empathy	1.489	75	0.141

Similarly, Independent Samples T-Test results for Presence showed no significant gender differences, t(75) = 0.672, p = 0.503, indicating that the sense of presence in the VR environment is not affected by gender. Hence, H6 is not supported.

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Table 9. *T-Test Results for Gender Differences in Presence*

	t	df	p
Presence	0.672	75	0.503

As for gender differences in Anti-Beef-Eating Willingness, using ANCOVA, controlling for T0_future_beef, no significant gender differences were found in changes to anti-beef-eating willingness, $F(1, 74) = 0.908$, $p = 0.344$. This suggests that gender does not significantly impact changes in participants' willingness toward beef consumption.H7a is not supported.

Table 10. *ANCOVA Results for Gender Differences in Anti-Beef-Eating Willingnesss*

Cases	Sum of Squares	df	Mean Square	F	p
T0_future_beef	602.842	1	602.842	310.068	< .001
Gender	1.765	1	1.765	0.908	0.344
Residuals	143.873	74	1.944		

ANCOVA results for changes in willingness toward the suffering of cows also showed no significant gender differences, $F(1, 74) = 0.002$, $p = 0.963$. This suggests that gender does not have a substantial impact on influencing participants' willingness toward animal suffering. H7b is not supported.

Table 11. *ANCOVA Results for Gender Differences in Willingness Toward the Suffering of Cows*

Cases	Sum of Squares	df	Mean Square	F	p
Gender	0.001	1	0.001	0.002	0.963
T0_CowsSuffer	36.522	1	36.522	71.582	< .001

doi:10.6342/NTU202504615

Cases	Sum of Squares	df	Mean Square	F	p
Residuals	37.756	74	0.510		

The ANCOVA analysis of future beef consumption willingness revealed no significant gender differences, $F(1, 74) = 0.283$, $p = 0.596$. This suggests that gender does not significantly influence participants' future plans regarding beef consumption.H8 is not supported.

Table 12. *ANCOVA Results for Gender Differences in Future Beef Consumption Willingness*

Cases	Sum of Squares	df	Mean Square	F	p
Gender	0.111	1	0.111	0.283	0.596
T0_BeefCons	45.238	1	45.238	115.773	< .001
Residuals	28.916	74	0.391		

Predictive Models in VR Context

Regarding H9, which explored the extent to which demographic variables (gender, individual differences in empathy and presence) could predict changes in anti-beef-eating willingness within the VR context, the regression analysis revealed a marginally significant effect of empathy (p = 0.055). In contrast, gender (p = 0.358) and age (p = 0.142) were not significant predictors. Accordingly, H9 is not supported.

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Table 13. *Regression Results for Predicting Changes in Anti-Beef-Eating Willingness*

Model		Unstandardized	Standard Error	Standardized[a]	t	p
M_0	(Intercept)	2.649	0.375		7.056	< .001
M_1	(Intercept)	3.713	1.719		2.160	0.034
	T0_Empathy	-0.799	0.409	-0.097	-1.954	0.055
	Gender	0.303	0.327		0.925	0.358
	Age	-0.038	0.025	-0.072	-1.484	0.142
	T0_future_beef	0.833	0.051	0.853	16.272	< .001

[a] Standardized coefficients can only be computed for continuous predictors.

None of the predictors, including Empathy (p = 0.598), gender (p = 0.552), and age (p = 0.986), showed significant effects in predicting changes in future beef consumption willingness.H10 is not supported.

Table 14. *Regression Results for Predicting Changes in Future Beef Consumption Willingness*

Model		Unstandardized d	Standard Error	Standardized[a]	t	p
M_0	(Intercept)	2.719	0.114		23.750	.001
M_1	(Intercept)	0.761	0.751		1.013	.314
	T0_Empathy	-0.098	0.184	-0.039	-0.530	0.598
	Gender	-0.089	0.149		-0.597	0.552
	Age	-2.059×10^{-4}	0.012	-0.001	-0.017	0.986

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Model		Unstandardized d	Standard Error	Standardized[a]	t	p
	T0_BeefCons	1.030	0.100	0.785	10.336	.001

[a] Standardized coefficients can only be computed for continuous predictors.

Regression analysis revealed no significant predictors for changes in willingness toward the suffering of cows. Empathy (p = 0.727), gender (p = 0.993), and age (p = 0.946) were all non-significant. Therefore, H11 is not supported.

Table 15. *Regression Results for Predicting Changes in Willingness Toward the Suffering of Cows*

Model		Unstandardized	Standard Error	Standardized[a]	t	p
M_0	(Intercept)	3.545	0.115		30.935	< .001
M_1	(Intercept)	0.825	0.891		0.926	0.357
	T0_Empathy	0.074	0.210	0.029	0.351	0.727
	Gender	0.001	0.174		0.008	0.993
	Age	9.150×10^{-4}	0.013	0.006	0.068	0.946
	T0_CowsSuffer	0.761	0.093	0.712	8.164	< .001

[a] Standardized coefficients can only be computed for continuous predictors.

doi:10.6342/NTU202504615

3.7. Discussion

The findings of this study illuminate the intricate relationships between empathy, presence, and the effectiveness of virtual reality (VR) interventions in shaping attitudes toward beef consumption. Consistent with Hypothesis 1, the results indicate that individuals with elevated levels of trait empathy are more likely to feel a heightened sense of presence within VR environments. This enhanced sense of immersion could increase the impact of VR interventions by intensifying users' involvement in the scenario.

With regard to Hypotheses 2, 3a, and 3b, the analysis revealed that VR presence exerts a significant direct effect on the reduction of future beef consumption willingness. Nevertheless, this impact was not mediated by alterations in willingness toward cow suffering, indicating that the effect of presence might function through other mechanisms beyond empathy for animal distress.

Furthermore, the backing of Hypothesis 4 emphasizes the crucial role that presence plays in shaping the impact of VR interventions. More specifically, the influence of VR on beef consumption intentions was noted only in participants who reported a strong sense of presence. This implies that the mere implementation of VR is insufficient to elicit behavioral change; rather, its success hinges on the degree of presence experienced and the individual's baseline level of empathy.

Importantly, the findings suggest that pre-existing empathy may exert a stronger influence than transient emotional shifts induced during the intervention. This emphasizes the role of trait empathy not only as a psychological disposition but also as a determining factor in the success of VR-based persuasive communication.

Overall, these results underscore the potential of VR as a powerful tool for promoting environmentally conscious and ethical actions, especially concerning dietary habits and views on animal welfare. Nevertheless, the effectiveness of VR may be

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limited in cases where users exhibit low empathy or a diminished sense of presence. In such instances, traditional video-based interventions may prove more impactful.

To sum up, this study concludes that VR interventions have the potential to significantly influence consumer attitudes and reduce meat (beef) consumption. Previous studies have consistently shown that women generally exhibit lower willingness to consume meat than men; however, the results of this study did not achieve statistical significance. Several potential explanations could account for this discrepancy. Firstly, the attributes of the sample utilized in this research may differ from those in previous research. Variations in cultural background, age distribution, dietary preferences, or educational levels could influence the extent to which gender differences manifest. For example, this study may have sampled a more homogeneous or context-specific group, reducing the variability needed to detect gender differences. Moreover, participants may come from a cultural context where willingness toward meat are less polarized by gender, thereby weakening the observed effects.

Second, societal and cultural changes over time may have contributed to the diminished gender differences. The growing popularity of plant-based diets and the rise in environmental and ethical awareness may have influenced men and women to adopt more similar willingness toward meat consumption. These changes could have blurred the traditional gender distinctions observed in earlier studies, particularly among younger generations who may prioritize sustainability or health concerns over traditional gender roles in dietary behavior.

Third, the size of the gender effect may be smaller than anticipated, making it difficult to detect with the current sample size. A lack of statistical power could result from a sample that is too small to capture subtle but meaningful differences. Additionally, unmeasured variables such as health consciousness, religious beliefs, or socioeconomic status may have a greater influence on meat consumption willingness

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in this sample, potentially overshadowing gender-related effects. For instance, individuals with strong health motivations or specific religious dietary restrictions may demonstrate willingness and behaviors that are less dependent on gender.

Fourth, the tools and methods used to measure willingness toward meat consumption may have influenced the findings. If the measurement instruments lacked sensitivity or were not well-suited to the sample's cultural context, they might not have captured the nuances of gender differences effectively. Previous research may have employed more culturally specific or psychometrically robust tools that could detect smaller effects.

Fifth, it is imperative to consider the impact of context and situational factors in shaping gender differences. Willingness toward meat consumption may not be universally tied to gender but may vary across cultural, economic, or environmental contexts. For example, in societies where meat is a less significant part of the diet or where plant-based alternatives are widely available, the gender gap may be less pronounced.

Finally, the lack of significant results in this study does not necessarily invalidate prior research but rather highlights the complexity of gender's role in dietary behaviors. It suggests that gender differences in willingness toward meat are not fixed and may rely on a variety of reasons, inclusive of culture, context, and the interplay of other demographic and psychological variables. These results add to the expanding field of research by emphasizing the need for more comprehensive techniques in examining gender-based differences in dietary preferences.

To conclude, although the outcomes of this research did not reproduce the significant gender differences reported in previous research, they provide valuable insights into the evolving nature of dietary behaviors. Future studies should consider exploring these relationships using larger and more diverse samples, incorporating

doi:10.6342/NTU202504615

additional variables such as cultural norms, personal values, and dietary motivations. This approach enables researchers to better understand the factors affecting meat eating and how gender dynamics interact with these elements across different sociocultural settings

doi:10.6342/NTU202504615

CHAPTER FOUR

CONCLUSION, LIMITATIONS, AND SUGGESTIONS

4.1. Conclusion

This research offers an in-depth understanding of how virtual reality (VR) can affect willingness and actions associated with meat consumption by concentrating on empathy and presence as key psychological factors. By synthesizing insights from prior research, it provides a nuanced view on the capacity of VR experiences to foster decision-making and drive behavioral change. Unlike earlier studies that mainly highlight VR's ability to foster empathy to shape behavioral outcomes, this research delves into how empathy, as a stable individual trait, interacts with the sense of presence to impact willingness and actions.

Previous research, including Herrera et al. (2018) and Bujić et al. (2020), has demonstrated VR's potential to evoke empathic responses and promote prosocial behaviors. Nevertheless, these studies typically assume that presence precedes empathy, portraying VR primarily as a tool to elicit emotional engagement. In contrast, this study finds that empathy itself may act as a precursor to presence. Participants with higher empathy scores reported a stronger sense of presence in VR environments, which significantly influenced their willingness toward beef consumption. This finding aligns with the theories of Lombard and Ditton (1997) and Nicovich et al. (2005), which emphasize the importance of individual differences, such as empathy, in shaping interactions with digital media. This reframing of the relationship between empathy and presence represents a significant theoretical contribution, providing a fresh lens through which to understand the psychological impact of VR.

Mediation analysis further elucidates the mechanisms by which VR influences dietary behavior. It reveals that willingness toward beef consumption mediate the

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relationship between presence and future consumption willingness, demonstrating how VR reshapes perceptions and willingness to drive behavioral change. Interestingly, empathy toward cow suffering, while enhancing presence, did not significantly mediate this relationship. This finding suggests that empathy primarily contributes to immersion rather than directly affecting behavior through willingness toward animal suffering, highlighting the need for further exploration of alternative pathways.

The study also underscores the pivotal role of presence in determining VR's effectiveness. Findings from the one-way ANOVA and post-hoc analyses reveal that participants in the high-presence VR group exhibited significantly greater reductions in their future beef consumption willingness compared to the low-presence group. These results emphasize the importance of designing VR content that maximizes presence to enhance its behavioral impact. Notably, the outcomes for the high-presence VR group were comparable to those of traditional video interventions, further underscoring the critical influence of immersion quality in driving behavioral change.

By incorporating empathy and presence into the analysis, this research emphasizes the mediating roles of these psychological mechanisms, offering a richer understanding of their interplay. The findings challenge the notion of VR as a "one-size-fits-all" intervention, emphasizing the need for tailoring VR experiences to individual characteristics to maximize their effectiveness.

Additionally, the study challenges existing assumptions about demographic influences on VR effectiveness. The absence of significant gender differences in empathy and presence suggests that VR interventions can resonate with a broad range of users, regardless of demographic factors. This finding underscores VR's potential as an inclusive tool for promoting behavioral and social change.

In conclusion, this study emphasizes VR's transformative capacity as an intervention tool for shaping dietary behaviors. By reinterpreting the connection

doi:10.6342/NTU202504615

between empathy and presence, the research offers an innovative theoretical framework for understanding the psychological processes that drive behavior change. The results stress the need to consider individual differences when designing VR interventions, ensuring that they appeal to a diverse range of audiences.

This approach enhances VR's effectiveness as a medium for fostering empathy, reshaping willingness, and promoting healthier and more sustainable behaviors. Ultimately, the study represents a significant step forward in applying VR to address critical societal challenges, such as encouraging ethical and sustainable dietary practices. By bridging the gap between emotional engagement and tangible behavioral outcomes, it paves the way for broader applications of immersive technologies in public health, education, and sustainability initiatives.

4.2. Practical implications

The practical applications of this study are far-reaching. It emphasizes the importance of tailoring VR interventions to individual differences in empathy, ensuring that content resonates with diverse audiences. Personalized VR experiences can amplify the emotional impact and maximize behavioral outcomes, making them particularly effective in promoting pro-social and environmentally responsible behaviors. Moreover, this study demonstrates how VR can be seamlessly integrated into public health campaigns, education programs, and sustainability initiatives, offering scalable solutions to some of society’s most pressing challenges.

Beyond its immediate applications, the study makes a broader interdisciplinary contribution by laying a foundation for future research across various domains. By establishing a theoretical framework that links empathy, presence, and behavioral change, this study provides insights that are relevant to fields such as environmental conservation, mental health advocacy, and social justice. The findings also encourage

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researchers to explore how immersive technologies can promote understanding and teamwork on a global scale, addressing important problems that transcend disciplinary boundaries.

Plus, the study raises important questions about the sustainability of behavioral changes induced by VR interventions. While this research focuses on short-term willingness shifts, it emphasizes the importance of further investigation into the long-term impact of repeated or enhanced VR experiences on consumer behavior. Such exploration is especially pertinent within the framework of worldwide initiatives aimed at minimizing the ecological footprint of dietary systems and encouraging responsible consumption habits. Understanding how to sustain and amplify the influence of VR interventions could significantly advance their application in public health and ethical advocacy.

Ultimately, this study enhances our comprehension of empathy as a dynamic psychological construct. By demonstrating that empathy is not only a stable individual trait but also a key factor influencing presence and behavioral outcomes, the study underscores the importance of individual psychological differences in shaping immersive experiences. This insight is vital for designing VR interventions that are not only impactful but also adaptable to diverse user profiles, ensuring inclusivity and effectiveness. By emphasizing the interplay between user characteristics and technological design, the study offers practical guidance for leveraging VR as a transformative resource to tackle ethical, environmental, and societal issues. In summary, this study marks an important advancement in comprehending how VR can be harnessed to influence willingness and behaviors related to meat consumption. By integrating theoretical, methodological, and practical insights, the study contributes to the development of innovative interventions that address critical societal challenges. It demonstrates the power of VR to create emotionally resonant and cognitively engaging

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experiences, paving the way for broader applications of immersive technologies in driving meaningful social and behavioral change.

4.3. Limitations and Suggestions

This study highlights the considerable capacity of virtual reality (VR) in encouraging healthier eating habits. The study's generalizability is constrained by its reliance on a Taiwanese sample. Given that dietary practices are deeply embedded in cultural contexts, the applicability of these results may be limited across other populations. Additionally, the use of self-reported questionnaires may introduce response bias, potentially affecting data accuracy.

The study was structured to assess the immediate impact of the VR intervention on attitudes toward meat consumption. Participants filled out questionnaires before and after the intervention, which gauged their meat consumption habits and willingness, allowing for the identification of short-term effects.

To investigate sustained impacts, a follow-up survey was carried out two weeks after the initial intervention. Nonetheless, due to the low response rate (fewer than 10 out of 142 participants), the follow-up data lacked adequate statistical power and representativeness. Consequently, these data were excluded from the final analysis and acknowledged as a limitation.

Comprehending the long-term viability of behavioral change is essential for creating impactful interventions. Evaluating the enduring influence of VR-based strategies can help validate their efficacy and support the implementation of long-term behavioral change initiatives. Future studies should consider employing improved engagement strategies to enhance follow-up participation. Techniques such as personalized reminders, frequent communication, and incentive-based participation

doi:10.6342/NTU202504615

(e.g., gift cards or prize draws) may help increase response rates and yield more robust longitudinal data.

In addition to quantitative methods, incorporating qualitative approaches such as in-depth interviews may provide a more comprehensive insight into participants' psychological and emotional responses. Such methods would facilitate a deeper understanding of how individuals internalize behavior change, thereby improving the design and effectiveness of future VR-based interventions.

A combined-methods strategy that incorporates both numerical and descriptive data could provide a more comprehensive assessment of VR interventions. While quantitative data highlights the degree of change, qualitative insights uncover the underlying factors, obstacles, and personal stories that influence behavioral shifts.

Our findings also raise important methodological considerations regarding empathy measurement. The study used a combined empathy scale, which, although practical, might mask the separate effects of cognitive and emotional empathy. Moreover, the current design did not allow for a direct comparison between integrated and separate empathy scales, thereby limiting the ability to assess their respective merits. Subsequent research should explore the distinct impacts of cognitive and emotional empathy within VR settings and consider creating hybrid scales that strike a balance between thoroughness and measurement efficiency.

An additional area that has not been fully explored is the impact of emotional biases on meat consumption behavior. To date, only a few studies, such as those by Pompian (2012) and Yuan et al. (2019), have thoroughly investigated emotional biases and their effect on consumer choices. Expanding on their conclusions, this research proposes that emotional biases could be a key factor in meat-related decisions. However, given the limited literature, this aspect remains a noted limitation and presents opportunities for future inquiry.

doi:10.6342/NTU202504615

Cultural and societal influences could also have an indirect impact on willingness and actions. Although not a primary focus of this study, these contextual elements are critical for interpreting behavioral outcomes and enhancing generalizability. The limited attention to cultural moderation in the existing research may limit the generalizability of the findings. Following studies should incorporate cultural variables to better understand how willingness is expressed and shaped across different societal contexts. Moreover, the intervention design did not account for individual differences in sensitivity to animal suffering, which may affect the perceived emotional impact of the VR experience. Tailoring VR content to accommodate diverse audience responses could enhance the effectiveness of such interventions.

To translate these findings into sustainable real-world strategies, several approaches are recommended. First, repeated VR exposure over time may reinforce empathy and promote long-term behavioral change. Second, integrating VR-based empathy interventions into public campaigns or educational initiatives, particularly in collaboration with health and environmental organizations, could amplify their impact. Third, policy advocacy aimed at institutionalizing VR empathy education in schools and workplaces may further support behavioral shifts.

By implementing these strategies, coming research can extend the reach and effectiveness of VR interventions. The current findings, while promising, highlight the importance of refining VR applications to account for emotional, cognitive, and cultural variability. Such progress has the capacity to greatly benefit societal well-being and ecological balance by promoting more empathetic and mindful consumption habits.

doi:10.6342/NTU202504615

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SUPPLEMENTARY NOTES ON METHOD

In the previously published study (Hou et al., 2024), the measurement method for *future beef consumption* was described as a multiple-choice question. However, in the actual study implementation, this variable was measured using an open-ended format, where participants were asked to indicate the number of times they expected to consume beef in the future. Due to adjustments during the writing and submission process, this difference was not fully reflected in the published version. This dissertation has revised the methodological description to align with the actual implementation, ensuring accuracy in reporting. This revision does not affect data processing, analytical methods, or the validity of the study's conclusions.

doi:10.6342/NTU202504615

APPENDICES

1. Questionnaire of Beef Consumption and Willingness

(1) Questions before experiment:

一、牛肉消費(Beef consumption)

1. 您在過去一週(7 天)的三餐中(早、中、晚餐)，有多常吃包含牛肉在內的食物或

食品，例如牛排、滷牛肉、牛肉麵或是牛肉乾？

在過去一週內，我大約吃_____次含牛肉的食物

(2) Question before and after experiment:

1. 您在未來一週的三餐中(早、中、晚餐)，有多想吃包含牛肉在內的食物或食品

例如牛排、滷牛肉、牛肉麵或是牛肉乾？

在未來一週內，我大約會吃_____次含牛肉的食物

2. 您一個星期(21 餐)內，有幾餐會想要吃牛肉或牛肉製的相關食品？_____餐

一、牛肉消費意願 (Willingness toward beef consumption)

1. 「每個人都應該減少吃牛肉是很重要的」，您對於這句話的想法是？

(1) 非常不同意

(2) 不同意

(3) 既不同意也不反對

(4) 不同意

(5) 非常不同意

2. 如果朋友要點餐吃牛肉料理，例如牛排、滷牛肉還有牛肉麵，我會贊成他們的決定。

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(1) 非常不同意

(2) 不同意

(3) 既不同意也不反對

(4) 不同意

(5) 非常不同意

3. 我認為吃牛肉是不對的行為。

(1) 非常不同意

(2) 不同意

(3) 既不同意也不反對

(4) 不同意

(5) 非常不同意

二、對於牛受苦的意願 Willingness toward cows suffering

1. 我認為吃牛肉會直接導致牛隻的痛苦。

(1) 非常不同意

(2) 不同意

(3) 既不同意也不反對

(4) 不同意

(5) 非常不同意

1. 我認為如果大家少吃一些牛肉或牛肉製品（如：牛排、牛肚、滷牛肉、牛肉麵或牛肉乾），牛隻就不需要面臨這麼多痛苦。

(1) 非常不同意

(2) 不同意

(3) 既不同意也不反對

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(4) 不同意

(5) 非常不同意

2. 我認為牛隻被屠宰、製作成牛肉製品（如：牛排、牛肚、滷牛肉、牛肉麵、或牛肉乾）的過程中，他們會面臨痛苦。

(1) 非常不同意

(2) 不同意

(3) 既不同意也不反對

(4) 不同意

(5) 非常不同意

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2. Revised Basic Empathy Scale (Before experiment)

描述	非常不同意	2	3	4	5	6	非常同意
我朋友的情緒不太會影響我	1	2	3	4	5	6	7
和正在為某件事情傷心的朋友待在一起，我也會跟著感到傷心	1	2	3	4	5	6	7
當我看到一部電影來到恐怖電影中的角色時，我會感到害怕	1	2	3	4	5	6	7
我很容易融入別人的感受中	1	2	3	4	5	6	7
看到他人受挫時，我不會感到難過	1	2	3	4	5	6	7
別人的感受對我並不會影響	1	2	3	4	5	6	7
看著電視，電視裡想悲傷的事情常令我感到難過	1	2	3	4	5	6	7
當我和感到害怕的朋友在一起時，我往往也會跟著害怕起來	1	2	3	4	5	6	7
我時常被朋友的情緒所牽動	1	2	3	4	5	6	7
我會因為朋友而影響	1	2	3	4	5	6	7
我理解別人在做某件事情時的快樂	1	2	3	4	5	6	7
當我的朋友感到害怕，我很容易就能發現	1	2	3	4	5	6	7
當有人感到退縮時，我通常可以理解他們的感受	1	2	3	4	5	6	7
當朋友感到悲傷的時候，我通常可以猜到	1	2	3	4	5	6	7
我通常在別人用告訴我之前就已經了解他們的感受	1	2	3	4	5	6	7

doi:10.6342/NTU202504615

人們在受到情緒時，我通常可以察到	1	2	3	4	5	6	7
當朋友生氣，我通常可以很快意識到	1	2	3	4	5	6	7
我時常不理解朋友的感受	1	2	3	4	5	6	7
我時常不清楚朋友何時感到關心	1	2	3	4	5	6	7
我很難弄清楚我的朋友們什麼時候開心							

3. Level of Presence (After Experiment)

請根據方才體驗過程中的感受，回答您對下方描述的同意程度。1 代表非常不同意，7 代表非常同意。請您用 1-7 之間的一個數字表示您的想法。

1. 我覺得我剛才好像真的身處在那個牧場裡
2. 我覺得我融入在那個虛擬環境中
3. 我覺得剛剛場景中的人事物真的環繞著我
4. 我覺得自己像是這段體驗內容的一部分
5. 我覺得剛才我所處的位置像是移動到了虛擬世界中了一樣

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4. Ethical Review Approval

國立臺灣大學
行為與社會科學研究倫理委員會

Research Ethics Committee
National Taiwan University
No. 1, Sec. 4, Roosevelt Rd., Taipei, Taiwan 10617, R.O.C
Phone: 3366-9956 Fax: 2362-9082

審查核可證明

核可日期：2023 年 7 月 18 日

倫委會案號： 202305HM005
核可證明有效期限： 2023 年 7 月 18 日 起至 2024 年 9 月 4 日
計畫名稱： 虛擬實境中的同情心與臨場感對肉類消費意願改變的研究
校/院/系/計畫主持人： 國立臺灣大學/生物資源暨農學院/生物產業傳播暨發展學系/侯佳宜 博士生
計畫文件版本日期： 【研究計畫書，2023 年 5 月 15 日】、【知情同意書，2023 年 6 月 7 日】、【招募文宣，2023 年 7 月 18 日】

上述計畫業經 2023 年 7 月 18 日 國立臺灣大學行為與社會科學研究倫理委員會同意，符合研究倫理規範。本委員會的運作符合本校行為與社會科學研究倫理準則與規範及政府相關法律規章。

本案需經研究經費補助單位核准同意後，該計畫始得執行。

計畫主持人最遲應於本核可證明到期前的 6 週，提出持續審查申請表，本案需經持續審查，方可繼續執行。 在計畫執行期間，若有計畫變更或嚴重不良反應事件，計畫主持人須依國內及本校相關法令規定通報本委員會。

行為與社會科學研究倫理委員會主任委員　鄭麗珍

副主任委員 曹峰銘 代行

Ethical Review Approval
National Taiwan University

Date of approval: July 18, 2023

NTU-REC No.: 202305HM005
Validity of this approval: from July 18, 2023 to September 04, 2024
Title of protocol: How Empathy and Presence in Virtual Reality Affect Willingness to Reduce Meat Consumption
University/ College/ Department/ Principal Investigator： National Taiwan University/College of Bio-Resources & Agriculture/ Department of Bio-industry Communication & Development/ Chia-I Hou
Version date of documents： 【Research Protocol, May 15, 2023】，【Informed Consent Form, June 7, 2023】，【Recruitment Advertising, July 18, 2023】

The protocol has been approved by Research Ethics Committee of National Taiwan University and has been classified as full board review on July 18, 2023 . The committee is organized under, and operates in accordance with, Social and Behavioral Research Ethical Principles and Regulations of National Taiwan University and governmental laws and regulations.

Approval by funding agency is mandatory before project implementation.

Continuing Review Application should be submitted to Research Ethics Committee no later than six weeks before current approval expired. The investigator is required to report protocol amendment and Serious Adverse Events in accordance with the National Taiwan University and governmental laws and regulations.

Chairperson　Li-Chen Cheng
Research Ethics Committee

Vice-chairperson *Feng-Ming Tsao* Deputizing for

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