

How Do Personality Traits Affect Consumer Decision-Making in Metaverse?

Nannan Xi
Tampere University
nannan.xi@tuni.fi

Elpida Bampouni
Tampere University
elpida.bampouni@tuni.fi

Chengyuan Li
University of Eastern Finland & Tampere University
chengyuan.li@tuni.fi

Juho Hamari
Tampere University
juho.hamari@tuni.fi

Abstract

There has been increased interest in new experiential dimensions generated in the new reality enabled by various extended reality (XR) technologies — The Metaverse. It is still unclear whether consumers' decision-making processes and patterns remain the same as in the physical world. Individual factors such as personality traits may influence decision-making in the Metaverse as such factors are usually in line with technology acceptance, efficacy, and attitude. In order to understand how personality traits influence consumer decision-making in the Metaverse, this study conducts a between-subject experiment (N=162) related to a daily-life shopping task to investigate the interaction effects between five different personality traits and two XR technologies (AR - Augmented Reality and VR - Virtual Reality) on two goals (avoidance vs. approach) which driving decision-making. The results indicate that neither VR nor AR influence decision-making goals, while consumers with high neuroticism have higher choice confidence when making decisions in VR.

Keywords: Mixed Reality, Purchase decision, Retailing, Decision satisfaction, Consumption.

1. Introduction

With the rapid advancement of immersive and interactive technologies such as augmented reality (AR) and virtual reality (VR), there is a belief that business life can be reshaped and facilitated by technologies in a more effective and efficient way (Altarteer et al., 2016; Rejeb et al., 2021; Zhao et al., 2017). In practice, AR has been widely used to present interactive and vivid extra information and personalized try-on experiences to augment consumer interaction with products, brands, and services (e.g., IKEA Place, L'Oréal Makeup Genius, and Google Maps Live View). As the representative technology for digital replication, VR has been adopted to provide high presence and immersive consumer

experiences where the physical world is fully blocked out and all sensory information can be virtually represented (Ning et al., 2023; Xi & Hamari, 2021). Intuitively, there is a key fundamental question from the perspective of consumer experience, regarding whether consumers employ similar decision-making processes, patterns, and goals as in the physical world.

For a long time, consumer decision-making has been considered a complex process and influenced by multiple factors (Azuma et al., 2006; Ranyard et al., 1997). Evaluation cost plays an important role in decision satisfaction and quality, which are determined by buyer's remorse and choice confidence (Heitmann et al., 2007). These are both related to the evaluation of uncertainty in decision-making. Emerging evidence has shown that consumers have higher self-efficacy and perceive less psychological cost and risk in XR-mediated environments (Shu et al., 2019; Xi et al., 2023; Smink et al., 2019). Therefore, consumers might have different considerations, concerns, and goals when making decisions in extended realities. What should also be noticed is that the attitude and adoption of XR might differ among individuals (Shu et al., 2019), which might moderately influence decision-making experiences. In this research, Metaverse is digitally mediated and encompasses multi-technology associated with digital reality including VR and AR (Hadi & Park, 2023; Ning et al., 2023; Chen et al., 2023).

In this study, we aim to explore the role of XR in influencing consumer decision-making regarding the decision-making goals, including anticipated regret and choice confidence. According to the regulatory focus theory, they are theorized as avoidance goals and approach goals, respectively. We conduct a 2 by 2 between-subjects design experiment based on four different self-constructed shopping environments to empirically examine the effects of AR and VR on choice confidence and anticipated regret, as well as the moderating effects of personality traits using the Big 5 (Rammstedt & John, 2007). The findings provide

valuable evidence on how consumers evaluate uncertainty and make purchase decisions in Metaverse business environments, further benefiting practitioners, retailers, and Metaverse designers.

2. Background and hypothesis

2.1 Shopping in Metaverse

Currently, Metaverse is considered as the interchangeable term of XR, which is the umbrella concept of all kinds of digital technology-mediated new realities such as augmented reality, virtual reality, mixed reality (MR), and their combinations (Chen et al., 2023; Xi et al., 2023). AR and VR are the two representative realities often defined from a technological perspective. AR represents the technologies that aim to modify the perceived reality by integrating digital sensory information with the current environment (Riar et al., 2022). On the contrary, VR technology aims to substitute and replace the current reality we can perceive in a digital way (Xi & Hamari, 2021). Augmented Virtuality (AV) refers to enhancing virtual reality experiences by overlaying additional content onto it. It involves superimposing AR technology onto the view of virtual reality, so creating a mixed-reality environment (Riar et al., 2022).

One of the mainly explored contexts in current Metaverse business research is shopping, a common activity in which everyone makes decisions. Following the theoretical guidance of the S-O-R (Stimulus-Organism-Response) framework, researchers attempt to discover and investigate whether consumers follow the same psychological response and behavior patterns when shopping in the Metaverse. On one hand, design-oriented studies have focused on the development of high-usability and high-efficiency XR shopping systems and platforms for enhancing our knowledge of the features, characteristics, and affordances of AR and VR technologies (Violante et al., 2019; Huang et al., 2019; Hsu et al., 2020). On the other hand, researchers have started to conduct more in-depth psychological studies to extract and develop new dimensions of consumer experiences by explaining the psychological mechanisms induced by different technological interventions (Kang et al., 2020; Smink et al., 2020; Kowalczyk et al., 2021). Overall, the majority of the previous studies have mostly focused on the advantages, benefits, and functions provided by XR shopping, such as immersive and enjoyable experiences (Peukert et al., 2019; Israel et al., 2019;), enhanced cognitive skills (Martínez-Navarro et al., 2019), and emotional arousal (Kang et al., 2020), but have rarely paid attention to how the decisions are formed and what factors would

influence the decision-making process, such as technological factors and consumer individual factors.

In the limited studies related to XR shopping decision-making, AR and VR as the two representative technologies are rarely compared (Xi et al., 2023). Such a gap might be related to an inconsistent conceptual understanding of XR and too specific study designs (Qin et al., 2021; Zhao et al., 2017). Due to the difficulty of creating XR shopping systems, quite a few studies have examined VR or AR based on existing applications and platforms (see e.g., Makeup Genius: Smink et al., 2020; IKEA Place: Qin et al., 2021; Sephora Virtual Artist: Smink et al., 2019), and it is almost impossible for researchers to conduct comparison studies. Also, decision-making outcomes instead of decision-making processes have received more attention. Researchers interpret consumer decision-making by measuring actual behavioral outcomes, such as purchase speed (time taken to make purchase decisions), purchase volume (e.g., amount, quantity), and purchase frequency (Siegrist et al., 2019; Zhao et al., 2018). However, it is still unknown how such purchase decisions are formed and driven. For example, what aspects and goals would consumers consider when purchasing products in the Metaverse? What are the differences when considering making decisions in various extended realities? Whether and how such differences would be influenced by different types of consumers? Addressing all these research questions can deepen our understanding of the role of XR in consumer decision-making.

2.2 Decision-making goals

Consumer decision-making is a complex process that involves identifying a need, searching for information, evaluating alternatives, and making a purchase decision. Within this process, consumer goals based on the regulatory focus theory (Higgins, 1997) play a crucial role. The regulatory focus theory posits that individuals have two primary motivational orientations: promotion focus and prevention focus. These orientations can be further categorized as *approach* and *avoidance* goals (Aaker & Lee, 2001). Specifically, approach goals focus on achieving a desired outcome, while avoidance goals focus on avoiding an undesired outcome, and they have a distinct impact on consumer decision-making (Aaker & Lee, 2001; Heitmann et al., 2007). In addition, consumers may differ in their goal-pursuit orientation, with some being more focused on actions promoting goal attainment (i.e., promotion focus) and others more focused on actions preventing potential obstacles to goal attainment (i.e., prevention focus) (Higgins, 2005). For example, research suggests that more promotion-

focused consumers tend to be more impulsive in their decision-making, while those who are more prevention-focused tend to be more cautious (Das, 2015).

In this context, anticipated regret and choice confidence serve as indicators or manifestations of individuals' engagement with avoidance and approach goals respectively, in the decision-making process. To be more specific, anticipated regret is a negative emotion experienced when individuals have the expectation or anticipation of feeling dissatisfaction or remorse over a decision due to the belief that an alternative choice could have resulted in a better outcome or avoided negative consequences (Zeelenberg et al., 2000; Heitmann et al., 2007). On the other hand, confidence refers to the level of certainty or belief that individuals have in their choice. Research suggests that consumers who possess confidence are more likely to make high-quality decisions and achieve desirable outcomes (Kidwell et al., 2008). Additionally, previous studies have shown that consumers' choice confidence and anticipated regret significantly influence their evaluation costs and drive their decisions (Heitmann et al., 2007). However, it remains unclear how XR environments influence consumers' approach and

avoidance goals. Therefore, further research is needed to address this gap and provide insights into *how consumers' approach and avoidance goals differ when making decisions in the Metaverse (RQ1)*.

2.3 Personality traits

Regarding Metaverse shopping, in addition to the technological factors, individual factors such as personality traits might also play a detrimental role in influencing consumer decision-making (Kassarjian, 1971). Personality is a complex and multifaceted construct that has been defined in various ways. Based on the personality theory, the Big Five personalities presented by Costa and McCrae have gained significant recognition for their comprehensive coverage of personality traits and standardized measurements, making them widely applied in academic research. These personalities include five core traits: *agreeableness*, *conscientiousness*, *extraversion*, *neuroticism*, and *openness* as shown in Table 1 (Costa & McCrae, 1992; Lauriola & Levin, 2001; Rammstedt & John, 2007; Thorp et al., 2023).

Table 1. The five core traits of the Big Five personality model

Traits	Definitions	Characteristics
Agreeableness	The tendency to be compassionate, cooperative, and considerate towards others.	Sympathetic, trusting, helpful, and cooperative.
Conscientiousness	The tendency to be organized and responsible.	Well-organized, reliable, and diligent.
Extraversion	The tendency to seek social interactions with others and experience positive emotions.	Outgoing, sociable, energetic, and talkative.
Neuroticism	The tendency to experience negative emotions.	Anxious, moody, sensitive, and nervous.
Openness	The tendency to be open to new experiences, ideas, and sensitive to art and beauty.	Imaginative, curious, creative, and adventurous.

Previous research has investigated the direct and indirect effects of personality on consumer behavior and retailing research. Research suggests that personality traits can indeed influence consumers' perceptions and preferences for different retail channels. For instance, individuals high in openness tend to be more willing to shop online, while those high in agreeableness may prefer in-store shopping experiences (Hermes & Riedl, 2021). Moreover, personality traits can influence online shopping passion, specific shopping motivations, and also behavior (Huang & Yang, 2010; Wang & Yang, 2008). For instance, a study found that individuals high in extraversion are more motivated by social factors, while those high in conscientiousness are more motivated by utilitarian factors (Huang & Yang, 2010). Thus, it is well documented that consumer personality has significant implications for marketers and retailers. Understanding consumer personality can help

businesses tailor their marketing strategies, and design products that align with consumers' preferences and motivations.

The increasing interest lies in comprehending the potential interactions between personality traits and XR environments, with a particular interest in their influence on experience and decision-making processes. While research in this area is still developing, recent studies suggest that personality traits may influence how users interact with immersive technology, such as psychological (e.g., presence) and physical (e.g., VR sickness) experiences in XR environments (Chakraborty et al., 2023; Thorp et al., 2023; Widyanti & Hafizhah, 2022), which in turn influence individual decisions and behaviors. Relevant research has reported that individuals with high agreeableness are more likely to approach the goal of achieving better performance in tasks in XR environments, whereas individuals with

high conscientiousness perform worse (Thorp et al., 2023). However, there is conflicting evidence regarding the impact of personality on purchasing behavior in XR environments. A few studies suggest that certain personality traits may affect consumers' behavior and decision-making processes in XR environments, while others have found no significant effects of personality on purchasing decisions in virtual reality (Schnack et al., 2021; Widyanti & Hafizhah, 2022). Therefore, by following the first research question, this study aims to address the second research question related to the effect of individual factors: *How do personality traits influence consumer decision-making goals when shopping in the Metaverse? (RQ2).*

3. Method

3.1 Experiment design

A factorial 2 (VR: with vs. without) \times 2 (AR: with vs. without) between-subjects experiment was conducted on the university campus. The control condition (non-XR) comprised a brick-and-mortar music store with LP records as purchasable products. Based on this version, the other three XR-mediated conditions were further constructed representing AR, VR, and AV (AR combined with VR) shopping environment respectively (see section 3.3 Materials). Participants were required to make purchase decisions within 10 minutes using a given €10 gift card. This study adhered to the Finnish National Board on Research Integrity TENK Guidelines 2019.

3.2. Participants

All participants of the study were volunteers recruited via campus advertisements during September–November 2019. A total of 162 university students with diverse backgrounds (33 countries) participated and successfully completed the experiment. The reported demographics were 54.9% male, while the age of 77.2% ranged within 20–29 years of age. The educational level of 57.8% of participants was BSc and 60.1% stemmed from engineering and technology fields. All participants were compensated with their selected products from the experiment, further contributing to the external validity of the design.

3.3 Materials

A brick-and-mortar music store was built in a physical space of 22 m². Then the store was scanned (using LiDAR, point cloud, textures, etc.) and recreated in Unity as a 3D 1-to-1 model. Similarly realistic 3D models of LP music records were made and displayed in the virtual conditions. A head-mounted display and controllers (Microsoft HoloLens 1 and Valve Index) were used for the XR-mediated environments (see Figure 1). Microsoft HoloLens 1 is an augmented reality headset that enables users to overlay holographic images onto their real-world environment. Valve Index is a high-fidelity virtual reality headset with a wide field of view, high-resolution displays, and precise motion tracking using base stations and controllers. The selection of LP records as the experiment products was based upon much consideration, taking into account realistic shopping experience, replicability in XR, and minimizing product knowledge bias of the students by using second-hand English LP records).



Figure 1. Devices used in the three XR conditions (left - Microsoft HoloLens 1; right - Valve Index)

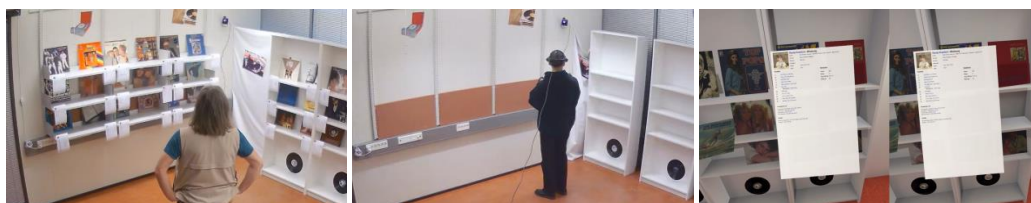


Figure 2. The physical shopping and virtual shopping environments

Note. The picture presented on the left side shows consumer A in the physical store. The middle picture shows the physical environment where consumer B is wearing a VR headset. For safety purposes, some shelves were removed during the experiments. The picture presented on the right side shows the virtual information and environment consumer B is investigating.

In each condition, 54 products were displayed in the music store (virtually or physically), and each of them was priced at €3, €6, or €9. In the control condition, participants entered the music store where physical products and printouts with information were placed next to them (extra product information collected from the Discogs music database). In the AR condition, participants could interact with the physical LP records, and upon inspection an augmented sheet of information appeared floating next to the product. In the VR condition, all aspects including the shopping environment and products were digitally replicated to match the physical condition (control) as closely as possible. In terms of AV condition (combining AR and VR), participants would receive and interact with the augmented floating information sheet while shopping in a fully virtual music store (see Figure 2).

3.4 Measures

In this study, the independent variables were VR and AR, which were coded as 1 (with) and 0 (without). The dependent variables were choice confidence and anticipated regret, while the moderating variables were the Big Five personality traits. Prior to the shopping task, participants completed a well-established Big Five personality traits questionnaire (i.e., BFI-10) (Rammstedt & John, 2007). Following the shopping task, participants were asked to complete separate questionnaires assessing choice confidence and anticipated regret. The choice confidence was measured by three items from Heitmann et al. (2007), rated on a 7-point scale from 1 (strongly disagree) to 7 (strongly agree), including *CC1: I felt confident when identifying product(s) that best match my preferences*; *CC2: I was convinced to find the product(s) that best fulfills my needs*; *CC3: It was impossible to be certain which product(s) fits my preferences best (reversed)*. The anticipated regret was measured by four items also from Heitmann et al. (2007), rated on a 7-point scale from 1 (strongly disagree) to 7 (strongly agree), including *AR1: After selecting the product(s) I wanted, I was still curious how much I would appreciate other products left in the shop*; *AR2: Even after finding a good option, I feared that I was overlooking better products*; *AR3: When I had made my final selection of product(s), I was worried that there might still be another superior product left in the shop*; *AR4: When I chose the product(s), I was curious about what would have happened had I chosen differently*.

3.5 Procedure

Before moving forward with the experiment, a pilot study was conducted to test all the steps and procedures of all conditions. The participants' demographic information including gender, age, income, education, and personality traits was collected and asked for in the recruitment survey. Participants were randomly assigned to one of the four shopping conditions. The researchers provided all participants with tutorial guidance and instructions according to an instruction manual, based on their respective conditions. The participants were given a €10 gift card and required to complete a 10-minute shopping task. They could decide upon any one or a combination of several products, and bring them to the cashier desk to use the gift card. After the experiment, participants were guided to complete a post-questionnaire including their decision confidence and anticipated regret. Upon completion, participants were able to ask further questions regarding the study's nature and kept their selected products as compensation. All participants signed a consent form indicating their voluntary participation in the study and consented to the study's data collection and management.

4. Data analysis and results

The data analysis method employed in this study was structural equation modeling (SEM), conducted using the statistical software Smart PLS 4.0. In the data preprocessing stage, the values of the multiple items within each variable were averaged to obtain means for variables. Subsequently, all variables were standardized to ensure comparability and mitigate the impact of scale differences. This procedure enables the variables to be analyzed on the same scale and facilitates the interpretation of path coefficients in the SEM analysis.

4.1 Descriptive results

Table 2 presents the descriptive information related to consumers' choice confidence and anticipated regret among each group in this study. Both choice confidence and anticipated regret were measured on a scale from 1 to 7. Note that the scores reported here are non-standardized and are derived from the original 7-point scale. The results show that the mean scores for choice confidence ranged from 4.83 ($SD = 0.64$) to 4.93 ($SD = 0.65$), and the mean scores for anticipated regret ranged from 4.09 ($SD = 1.52$) to 4.60 ($SD = 1.55$) across the four groups. The highest mean score for anticipated regret was reported by Group 3 (AR), while the lowest mean score was reported by Group 1 (Real).

Table 2. The Mean and SD of two dependent variables across all four conditions

Group	AR	VR	N	Choice confidence (Approach goal)		Anticipated regret (Avoidance goal)	
				<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
				1	without	without	41
2	without	with	40	4.93	0.65	4.41	1.23
3	with	without	42	4.85	0.92	4.60	1.55
4	with	with	39	4.84	0.73	4.44	1.26

4.2 Main and moderating effects

4.2.1 Approach goal: Choice confidence. In order to examine the moderating effect of personality traits (agreeableness, conscientiousness, extraversion, neuroticism, and openness) on the effect of VR and AR on choice confidence, multiple moderation analyses were conducted. The results indicated that neither VR nor AR had a statistically significant relationship with choice confidence (*p-values* > .05). The results of

moderator analysis for choice confidence are presented in Table 3.

Of the five personality traits, only neuroticism moderated the relationship between VR and choice confidence ($\beta = 0.456, t = 2.243, p = .025$). Specifically, the positive relationship between VR and choice confidence was stronger for individuals who scored high in neuroticism. However, the moderating effects of personality traits on the relationship between AR and choice confidence were statistically insignificant (*p-values* > .05).

Table 3. Results of the moderation analysis for choice confidence (approach goal)

Relationship	β	<i>t</i> -value	<i>p</i> -values	95% <i>CI</i>	
				lower	upper
AR → Choice confidence	-0.049	0.286	.775	-0.379	0.293
VR → Choice confidence	0.022	0.130	.897	-0.328	0.350
Agreeableness → Choice confidence	-0.169	1.142	.253	-0.453	0.140
Conscientiousness → Choice confidence	0.019	0.114	.910	-0.286	0.371
Extraversion → Choice confidence	-0.079	0.603	.547	-0.368	0.153
Neuroticism → Choice confidence	-0.302	1.689	.091	-0.623	0.066
Openness → Choice confidence	0.128	0.882	.378	-0.136	0.439
Agreeableness × AR → Choice confidence	0.132	0.794	.427	-0.198	0.456
Conscientiousness × AR → Choice confidence	-0.253	1.379	.168	-0.610	0.109
Extraversion × AR → Choice confidence	0.360	1.904	.057	-0.007	0.725
Neuroticism × AR → Choice confidence	0.219	1.026	.305	-0.210	0.634
Openness × AR → Choice confidence	0.032	0.189	.850	-0.330	0.344
Agreeableness × VR → Choice confidence	0.268	1.553	.120	-0.073	0.604
Conscientiousness × VR → Choice confidence	0.288	1.495	.135	-0.113	0.638
Extraversion × VR → Choice confidence	-0.209	1.060	.289	-0.564	0.205
Neuroticism × VR → Choice confidence	0.456	2.243	.025*	0.056	0.847
Openness × VR → Choice confidence	-0.173	0.983	.326	-0.505	0.178

Note. Bootstrapping sample = 5000, β = standard regression coefficient, *CI* = confidence interval. The significant coefficient path is bolded, significance level: * *p* < .05.

4.2.2 Avoidance goal: Anticipated regret. The analysis explored the moderating effects of personality traits on the relationship between VR and AR with anticipated regret. The results of the study are presented in Table 4. The results indicated that the main effects of VR and AR on anticipated regret were not statistically significant (*p-values* > .05), indicating no direct

relationship between these variables and anticipated regret. However, individuals high on neuroticism experienced significantly more anticipated regret ($\beta = 0.421, t = 2.420, p = .016$), suggesting that neuroticism is a significant predictor of anticipated regret.

Regarding the moderating effects, the effects between agreeableness, conscientiousness, extraversion,

neuroticism, openness, and VR or AR on anticipated regret were all insignificant (p -values > .05), indicating that these personality traits neither moderated the relationship between VR and anticipated regret nor the relationship between AR and anticipated regret.

In summary, the results suggest that VR and AR did not have significant direct effects on anticipated regret. Among the five traits, neuroticism was significantly associated with anticipated regret. Moreover, none of the personality traits moderated the relationship between the two XR technologies and anticipated regret.

Table 4. Results of the moderation analysis for anticipated regret (avoidance goal)

Relationship	β	t -value	p -values	95% CI	
				lower	upper
AR → Anticipated regret	0.138	0.787	.431	-0.210	0.478
VR → Anticipated regret	-0.020	0.119	.905	-0.363	0.309
Agreeableness → Anticipated regret	-0.069	0.355	.722	-0.436	0.313
Conscientiousness → Anticipated regret	0.241	1.323	.186	-0.155	0.575
Extraversion → Anticipated regret	0.065	0.427	.669	-0.218	0.380
Neuroticism → Anticipated regret	0.421	2.420	.016*	0.027	0.723
Openness → Anticipated regret	0.023	0.133	.894	-0.269	0.401
Agreeableness × AR → Anticipated regret	0.125	0.673	.501	-0.242	0.482
Conscientiousness × AR → Anticipated regret	-0.345	1.895	.058	-0.682	0.038
Extraversion × AR → Anticipated regret	0.007	0.037	.970	-0.366	0.392
Neuroticism × AR → Anticipated regret	-0.213	1.030	.303	-0.593	0.198
Openness × AR → Anticipated regret	-0.005	0.028	.978	-0.358	0.322
Agreeableness × VR → Anticipated regret	-0.261	1.446	.148	-0.636	0.073
Conscientiousness × VR → Anticipated regret	-0.208	1.138	.255	-0.564	0.153
Extraversion × VR → Anticipated regret	-0.098	0.498	.619	-0.457	0.298
Neuroticism × VR → Anticipated regret	-0.325	1.528	.127	-0.739	0.095
Openness × VR → Anticipated regret	0.080	0.436	.663	-0.282	0.427

Note. Bootstrapping sample = 5000, β = standard regression coefficient, CI = confidence interval. The significant coefficient path is bolded, significance level: * p < .05.

5. Discussion

Finding 1. Neither VR nor AR had a significant direct impact on consumer decision-making goals.

The results indicate that both VR and AR did not significantly influence consumers' choice confidence and anticipated regret. This may imply that the VR and AR-enabled experiences employed in this study did not elicit significant emotional or cognitive differences in participants, which could have affected their choice confidence and anticipated regret. Previous research has shown that the effectiveness of VR and AR in influencing psychological outcomes may vary depending on the specific characteristics and content of the experiences (Riar et al., 2022; Xi & Hamari, 2021). It is possible that the VR and AR experiences employed in this study did not incorporate elements that were particularly influential in shaping choice confidence and anticipated regret. Further research could explore the specific features and design factors that might enhance the impact of VR and AR on these psychological constructs.

Finding 2. Regardless of XR technologies, consumers high in neuroticism were more likely to choose the avoidance approach (e.g., high anticipated regret) when making decisions.

The results demonstrate that a positive association between neuroticism and anticipated regret aligns with previous research highlighting the role of neuroticism in decision-making. Neurotic individuals tend to exhibit higher levels of anxiety, worry, and sensitivity to potentially negative outcomes (Lauriola & Levin, 2001). This heightened sensitivity may lead to a greater tendency of anticipated regret, as individuals with neuroticism are more likely to make impulsive purchases and experience anticipatory feelings of regret (Olsen et al., 2016). Interestingly, such a relationship would not seem to be influenced by virtual and augmented technologies as there was no significant effect between neuroticism and AR and no significant effect between neuroticism and VR on anticipated regret. The insignificant results also provide us with a more optimistic view regarding using Metaverse — namely that consumers with a neuroticism-oriented trait would not perceive more negative experiences.

Finding 3. *When shopping in VR-mediated environments, consumers high in neuroticism were more likely to make decisions with high choice confidence.*

While it is still worth mentioning that neuroticism almost had a negative effect on choice confidence ($\beta = -0.302$, $p = 0.091$), the significant interaction effect between neuroticism and VR suggests that there might be substitution relationship between the influence of VR and neuroticism on choice confidence. Compared with non-VR environments, consumers with higher levels of neuroticism had the tendency to seek for and increase choice confidence in virtual reality. The moderating effects of neuroticism could be explained by the heightened emotional engagement and perceived realism that VR can provide for individuals with neurotic tendencies. VR has been shown to elicit stronger emotional responses and immersion compared to other technologies (Riva et al., 2007). For individuals high in neuroticism, immersive VR may enhance their confidence in decision-making, as they perceive the virtual context as more reliable and trustworthy. These features provided neurotic individuals with a greater sense of security and self-assurance to approach their goals. However, individuals low in neuroticism may not experience the same level of emotional engagement or perceive the virtual environment as strongly related to their decision-making confidence. Therefore, in VR-mediated environments, individuals with higher levels of neuroticism are more inclined to approach goals and ultimately influence their consumer decision-making through the VR-mediated enhancement of their confidence.

Finding 4. *When shopping in the AR-mediated environment, consumers' personality traits did not influence decision-making goals.*

The results suggest that the Big Five personality traits had no moderating effect on the relationship between AR and two decision-making goals (choice confidence and anticipated regret). This may be due to the influence of factors other than individual differences in personality traits on the effects of AR. Previous research indicates that contextual factors, task characteristics, and the specific content of AR experiences are more closely related to decision-making outcomes (Xi et al., 2023). The present study may have focused on aspects of AR that did not strongly engage with the individual differences represented by the Big Five personality traits. Additionally, the complex nature of the relationship between personality traits and decision-making suggests that the moderating effects of personality traits may depend on specific contextual conditions (Hermes & Riedl, 2021). Other individual differences or psychological processes not captured by the Big Five personality traits might have a more

prominent role in shaping the relationship between AR and decision-making goals.

6. Contribution

This study advances our understanding of personality traits regarding consumer decision-making confidence and regret in the context of XR shopping. We contribute to the existing literature of consumer psychology, marketing management, and XR research. We conducted a vigorous experiment design with high external validity, further contributing to the scientific corpus of methodological research by employing five different realities and maintaining the same level of informativeness, thus making our results directly comparable through different conditions. In addition, our findings inform the development and enhancement of XR user experience in various domains, which further promotes the adoption of XR, especially in the fields of service and consumption. Our study also enriches consumer psychology research, offering a deeper understanding regarding the factors influencing consumer behavior.

Our research has practical implications for marketing management that seeks to understand and optimize consumer decision-making processes in XR, provide insights into tailored marketing strategies to enhance customer satisfaction or effective marketing campaigns that align with consumer needs. Similarly, retailers can use our XR insights to adjust their virtual product strategies based on certain personality traits, such as neuroticism, conducting trials, or providing personalized recommendations and marketing messages to further support customers, which is consequently likely to increase consumer satisfaction and loyalty. Complementing that, XR/UI developers could also create interfaces that enhance decision confidence, incorporating features that align with consumer personality traits.

7. Limitations

This experiment investigated the consumer decision-making of 162 university students in a 10-minute shopping task under four different conditions. Even though students were considered an appropriate sample as they can afford the presented products and have a high acceptance towards XR technology-mediated shopping, other groups of consumers should also be considered for future laboratory or field studies to improve the generalizability of the findings. In addition, the consumer decision-making process varies by product type, price, and value. In this study, cheap hedonic products (maximum price €9) were selected.

The effort, challenges, and risk-taking in making decisions for second-hand music LP products are generally lower than making decisions for fixed assets, virtual assets, or luxury brands. Therefore, future studies are encouraged to examine the research questions proposed in this study in other shopping contexts. In addition, future studies could also explore consumer decision-making activation of emotional and cognitive mechanisms (e.g., attention), responses to tailored XR experiences, cultural effects, and importantly, the ethical considerations of use in such profit-motivated fields. Lastly, further directions could investigate the impact of multisensory feedback on behavior and satisfaction provided from XR environments, virtual shops, and digital products.

8. Acknowledgement

This work was supported by the KAUTE Foundation under Grant No. 20190003 and No. 20200531; OP Ryhmän Tutkimussäätiö under Grant No. 20200040; Liikesivistysrahasto under Grant No. 180386 (VIRTUMER) and No. 210301 (GAMETH); Academy of Finland under Grant No. 337653 (UNITE) and the Nasdaq Nordic Foundation (Investigame). This work was carried out with the support of the Centre for Immersive Visual Technologies (CIVIT) research infrastructure in Tampere University, Finland. Special thanks go to Juan Chen, Filipe Gama, Henry Korkeila, Henrietta Jylhä, and Shuo Yang's contributions to the XR environment development, experiment design and implementation. The authors would also like to thank all student participants from Tampere University, Finland.

9. References

- Aaker, J. L., & Lee, A. Y. (2001). "I" seek pleasures and "we" avoid pains: The role of self-regulatory goals in information processing and persuasion. *Journal of Consumer Research*, 28, 33–49.
- Altarteer, S., Charissis, V., Harrison, D., & Chan, W. (2016). Product customisation: Virtual reality and new opportunities for luxury brands online trading. *Proceedings of the 21st International Conference on Web3D Technology (Web3D '16)*, 173–174.
- Azuma, R., Daily, M., & Furmanski, C. (2006). A Review of Time Critical Decision Making Models and Human Cognitive Processes. *2006 IEEE Aerospace Conference*, 1–9.
- Costa, P. T., & McCrae, R. R. (1992). Normal personality assessment in clinical practice: The NEO Personality Inventory. *Psychological assessment*, 4(1), 5.
- Chakraborty, D., Polisetty, A., Khorana, S., & Buhalis, D. (2023). Use of metaverse in socializing: Application of the big five personality traits framework. *Psychology and Marketing*, 40(10), 2132–2150.
- Chen, J., Xi, N., Pohjonen, V & Hamari, J. (2023). Paying Attention in Metaverse: An Experiment on Spatial Attention Allocation in Extended Reality Shopping. *Information Technology & People*. In press.
- Das, G. (2015). Retail shopping behaviour: Understanding the role of regulatory focus theory. *The International Review of Retail, Distribution and Consumer Research*, 25, 431–445.
- Hadi, R., Melumad, S., & Park, E. S. (2023). The Metaverse: A New Digital Frontier for Consumer Behavior, *Journal of Consumer Psychology*.
- Heitmann, M., Lehmann, D. R., & Herrmann, A. (2007). Choice Goal Attainment and Decision and Consumption Satisfaction. *Journal of Marketing Research*, 44(2), 234–250.
- Hermes, A., & Riedl, R. (2021). Influence of personality traits on choice of retail purchasing channel: literature review and research agenda. *Journal of Theoretical and Applied Electronic Commerce Research*, 16(7), 3299-3320.
- Higgins, E. T. (2005). Value From Regulatory Fit. *Current Directions in Psychological Science*, 14(4), 209–213.
- Hsu, W. C., Chen, P. H., & Chen, C. Y. (2020). An Exploration of the Impact of Virtual Reality Interfaces on Online Shopping. *Information Resources Management Journal*, 33(2), 19–39.
- Huang, J.-H., & Yang, Y.-C. (2010). The Relationship Between Personality Traits and Online Shopping Motivations. *Social Behavior and Personality: An International Journal*, 38(5), 673–679.
- Huang, Y. C., Hu, S. Y., Wang, S. T., & Huang, S. C. C. (2019). Exploration of virtual reality-based online shopping platform. In *HCI International 2019-Posters: 21st International Conference, HCII 2019, Orlando, FL, USA, July 26–31, 2019, Proceedings, Part III 21* (pp. 81–88). Springer International Publishing.
- Israel, K., Zerres, C., Tscheulin, D. K., Buchweitz, L., & Korn, O. (2019). Presenting your products in virtual reality: do not underestimate cybersickness. In *HCI in Business, Government and Organizations. eCommerce and Consumer Behavior: 6th International Conference, HCIBGO 2019, Held as Part of the 21st HCI International Conference, HCII 2019, Orlando, FL, USA, July 26-31, 2019, Proceedings, Part I 21* (pp. 206-224). Springer International Publishing.
- Kassarjian, H. H. (1971). Personality and Consumer Behavior: A Review. *Journal of Marketing Research*, 8(4), 409–418.
- Kang, H. J., Shin, J. H., & Ponto, K. (2020). How 3D virtual reality stores can shape consumer purchase decisions: The roles of informativeness and playfulness. *Journal of Interactive Marketing*, 49, 70–85.
- Kidwell, B., Hardesty, D. M., & Childers, T. L. (2008). Emotional Calibration Effects on Consumer Choice. *Journal of Consumer Research*, 35(4), 611–621.
- Kowalczyk, P., Siepmann (née Scheiben), C., & Adler, J. (2021). Cognitive, affective, and behavioral consumer responses to augmented reality in e-commerce: A comparative study. *Journal of Business Research*, 124, 357–373
- Lauriola, M., & Levin, I. P. (2001). Personality traits and risky decision-making in a controlled experimental task: An

- exploratory study. *Personality and Individual Differences*, 31, 215–226.
- Martínez-Navarro, J., Bigné, E., Guixeres, J., Alcañiz, M., & Torrecilla, C. (2019). The influence of virtual reality in e-commerce. *Journal of Business Research*, 100, 475–482.
- Ning, H., Wang, H., Lin, Y., Wang, W., Dhelim, S., Farha, F., Ding, J., & Daneshmand, M. (2023). A Survey on the Metaverse: The State-of-the-Art, Technologies, Applications, and Challenges. *IEEE Internet of Things Journal*.
- Olsen, S. O., Tudoran, A. A., Honkanen, P., & Verplanken, B. (2016). Differences and Similarities between Impulse Buying and Variety Seeking: A Personality-based Perspective. *Psychology & Marketing*, 33(1), 36–47.
- Peukert, C., Pfeiffer, J., Meißner, M., Pfeiffer, T., & Weinhardt, C. (2019). Shopping in virtual reality stores: The influence of immersion on system adoption. *Journal of Management Information Systems*, 36(3), 755–788.
- Qin, H., Peak, D. A., & Prybutok, V. (2021). A virtual market in your pocket: How does mobile augmented reality (MAR) influence consumer decision making? *Journal of Retailing and Consumer Services*, 58, 102337.
- Rammstedt, B., & John, O. P. (2007). Measuring personality in one minute or less: A 10-item short version of the Big Five Inventory in English and German. *Journal of Research in Personality*, 41(1), 203–212.
- Ranyard, R., Crozier, W. R., & Svenson, O. (Eds.). (1997). *Decision making: Cognitive models and explanations* (Vol. 1). Psychology Press.
- Rejeb, A., Rejeb, K., & Keogh, J. G. (2021). Enablers of augmented reality in the food supply chain: A systematic literature review. *Journal of Foodservice Business Research*, 24(4), 415–444.
- Riar, M., Xi, N., Korbil, J. J., Zarnikow, R., & Hamari, J. (2022). Using augmented reality for shopping: A framework for AR induced consumer behavior, literature review and future agenda. *Internet Research*, 33(1), 242–279.
- Riva, G., Mantovani, F., Capideville, C. S., Preziosa, A., Morganti, F., Villani, D., Gaggioli, A., Botella, C., & Alcañiz, M. (2007). Affective interactions using virtual reality: The link between presence and emotions. *Cyberpsychology & Behavior: The Impact of the Internet, Multimedia and Virtual Reality on Behavior and Society*, 10(1), 45–56.
- Schnack, A., Wright, M. J., & Elms, J. (2021). Investigating the impact of shopper personality on behaviour in immersive Virtual Reality store environments. *Journal of Retailing and Consumer Services*, 61, 102581.
- Shu, Y., Huang, Y.-Z., Chang, S.-H., & Chen, M.-Y. (2019). Do virtual reality head-mounted displays make a difference? A comparison of presence and self-efficacy between head-mounted displays and desktop computer-facilitated virtual environments. *Virtual Reality*, 23(4), 437–446.
- Siegrist, M., Ung, C.-Y., Zank, M., Marinello, M., Kunz, A., Hartmann, C., & Menozzi, M. (2019). Consumers' food selection behaviors in three-dimensional (3D) virtual reality. *Food Research International*, 117, 50–59.
- Smink, A. R., Frowijn, S., van Reijmersdal, E. A., van Noort, G., & Neijens, P. C. (2019). Try online before you buy: How does shopping with augmented reality affect brand responses and personal data disclosure. *Electronic Commerce Research and Applications*, 35, 100854.
- Smink, A. R., van Reijmersdal, E. A., van Noort, G., & Neijens, P. C. (2020). Shopping in augmented reality: The effects of spatial presence, personalization and intrusiveness on app and brand responses. *Journal of Business Research*, 118, 474–485.
- Thorp, S. O., Rimol, L. M., & Grassini, S. (2023). Association of the big five personality traits with training effectiveness, sense of presence, and cybersickness in virtual reality. *Multimodal Technologies and Interaction*, 7(2), 11.
- Violante, M. G., Vezzetti, E., & Piazzolla, P. (2019). How to design a virtual reality experience that impacts the consumer engagement: The case of the virtual supermarket. *International Journal on Interactive Design and Manufacturing*, 13, 243–262.
- Wang, C.-C., & Yang, H.-W. (2008). Passion for Online Shopping: The Influence of Personality and Compulsive Buying. *Social Behavior and Personality: An International Journal*, 36(5), 693–706.
- Widyanti, A., & Hafizhah, H. N. (2022). The influence of personality, sound, and content difficulty on virtual reality sickness. *Virtual Reality*, 26(2), 631–637.
- Xi, N., & Hamari, J. (2021). Shopping in virtual reality: A literature review and future agenda. *Journal of Business Research*, 134, 37–58.
- Xi, N., Chen, J., Gama, F., Riar, M., & Hamari, J. (2023). The challenges of entering the metaverse: An experiment on the effect of extended reality on workload. *Information Systems Frontiers*, 25(2), 659–680.
- Zeelenberg, M., Van Dijk, W. W., Manstead, A. S., & van der Pligt, J. (2000). On bad decisions and disconfirmed expectancies: The psychology of regret and disappointment. *Cognition & Emotion*, 14(4), 521–541.
- Zhao, Y., Ham, J., & van der Vlist, J. (2018). Persuasive virtual touch: The effect of artificial social touch on *XInteraction: 6th International Workshop, Symbiotic 2017, Revised Selected Papers 6* (pp. 98–109). Springer International Publishing.
- Zhao, H., Huang, F., Spence, C., & Wan, X. (2017). Visual search for wines with a triangle on the label in a virtual store. *Frontiers in psychology*, 8, 2173.