AMCIS 2023 Proceedings

SIG CORE - Cognitive Research in IS

Aug 10th, 12:00 AM

Decision-Making Styles in Metaverse: Effects of Immersion and Embodiment

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Recommended Citation

Bampouni, Elpida; Xi, Nannan; and Hamari, Juho, "Decision-Making Styles in Metaverse: Effects of Immersion and Embodiment" (2023). *AMCIS 2023 Proceedings*. 3.
https://aisel.aisnet.org/amcis2023/sig_core/sig_core/3

Decision-Making Styles in Metaverse: Effects of Immersion and Embodiment

Completed Research Full Paper

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Abstract

Decision-making is a vital skill of our daily cognitive arsenal. The rise of virtual reality (VR) worlds like the metaverse, have created a new need to investigate human behavior under a technologically novel and multisensory prism. In this study, we experimentally investigate types of decision-making in artificial realities mediated by different levels of immersion (PC monitor vs. VR HMD) and sense of embodiment (self-motion vs. self-anchored). Participants (N=183) conducted a daily-life decision-making task of financial allocation, based on evaluating either a 3D graph or 2D graph containing price information across different periods. Five decision-making styles are evaluated including Rational, Intuitive, Dependent, Avoidant, and Spontaneous. Our results indicate that decision-making styles do not differ between diverse virtual realities, and instead remain similar to the control condition. However, due to the flexible nature of decision-making it is possible that content and environmental factors are still likely to influence decision-making in VR experiences.

Keywords

Decision making, virtual reality, extended reality, physical movement, 3D, 2D, data representation

Introduction

Decision-making is a crucial skill for our everyday lives. It is used to determine daily actions on small matters like what to wear or eat, as well as for more significant ones such as career choices, relationships, and financial investments. The quality of our decisions determines the outcome of our experience, paving the way towards success or negative consequences. Prior research has established that decision-making is flexible and adjustable in order to serve our needs under various situations (Payne et al., 1993). It is therefore essential to investigate decision-making and understand how we make decisions in different circumstances and environments.

The rise of technology and digital worlds like the metaverse, make possible many of our future endeavors to be actuated in the virtual world. These interactions would be qualitatively different from our traditional dealings with technology (Han et al., 2022). The metaverse brings forth elements of high immersion and multisensory input such as motion, in our digital interactions (Campos & Bülthoff, 2012; Slater et al., 1995). These factors are known to influence cognitive processes in diverse ways that are not yet fully understood (Campos & Bülthoff, 2012; Friedrich et al., 2021). Having established the adjustability decision-making demonstrates, and the increasing use of virtual realities in the daily context, it is integral to expand research regarding our dealings within virtual realities.

In this study we examine whether and how different virtual realities influence decision-making approach. For this reason, 4 conditions were developed based on 2 different levels of immersion (high: VR HMD, or low: PC Monitor) and 2 levels of sense of embodiment (high: self-motion, or low: self-anchored), to be compared to a control condition. This experiment examines decision-making using a financial investment task providing a 3D graph (2D for control condition), which is to be explored by the participants (N=183) before allocating their imaginary funds. A questionnaire distinguishing between 5 styles of decision-making, including *rational, intuitive, dependent, avoidant,* and *spontaneous*, is used to evaluate behavioral approaches for each condition (Scott & Bruce, 1995). This study contributes to our understanding of decision-making in realistic scenarios situated in the metaverse, and provides valuable implications to designers, developers, and practitioners.

Background

Immersive Realities and Metaverse

Metaverse is developing from a hyped term to an academic concept, it has gained significant attention in recent years as a platform for online experiences, commerce, and entertainment, connecting physical reality with digital virtuality. It refers to a post-reality shared virtual world, where users can engage in fully immersive and multisensory interactive experiences (Mystakidis, 2022). It is closely associated with existing technologies of virtual reality (VR), which provide the means to create realistic and engaging virtual spaces (Mystakidis, 2022). In the VR metaverse there are two core characteristics crucial for user experience, immersion and sense of embodiment (Steur, 1992; Slater & Wilbur, 1997; Mystakidis, 2022).

Immersion refers to the level of sensory and psychological engagement a user experiences within the virtual environment (Slater & Wilbur, 1997; Xi & Hamari, 2021). The sensory part of immersion is primarily controlled by the technological capabilities of the VR system, nowadays often in the form of a stereoscopic head-mounted display (HMD). The type of technological display has been shown to play a significant role in achieving immersive experiences (Buttussi & Chittaro, 2018). On the other hand, psychological immersion, or presence, often refers to the user's belief and feeling of "being there" (Slater & Wilbur, 1997; Xi & Hamari, 2021). Another important characteristic of VR is interactivity, which refers to the ability of the user to have an impact on the virtual environment (Mütterlein, 2018; Slater & Wilbur, 1997), influenced and influencing both components of immersion. These qualities are closely linked to each other, and together capable of generating highly immersive experiences (Mütterlein, 2018; Slater & Wilbur, 1997).

An additional contributor to immersive experiences is multisensory feedback and our sense of embodiment through motion. Our bodies as twofold, experience worldly things and are experienced as a thing in the world (Wehrle, 2020). A sense of embodiment, as the sense of body existence (da Silveira Coêlho et al., 2022), in virtual contexts is highly affected by our sensorimotor system, using our sense of self-location, agency, and body ownership (Kilteni et al., 2012). While visual and audio feedback are commonly encountered modalities in the metaverse, physical motion and locomotion are similarly vital and easily implementable. Self-motion enables users to interact with the virtual world in a more intuitive and natural way, further contributing to our sense of immersion (Rheingold, 1991; Slater et al., 1995). Self-motion in the virtual (or real) world, utilizes several sensory systems, including visual and proprioceptive inputs (Campos & Bülthoff, 2012). While several techniques have been developed to create a sense of motion in VR (Boletsis & Chasanidou, 2022), physical self-motion has been shown to influence our cognitive functions and perception (Friedrich et al., 2021; Steinicke et al., 2013).

Decision-Making

Decision-making (DM) is the executive function responsible for determining the best course of action among different options. As a consequence of its paramount role in daily world applications, it has been the epicenter of research in multiple fields such as psychology, neuroscience, business and economics, and computer science (Fellows, 2004). DM requires the integration of diverse pre-existing and newly acquired information, including multisensory inputs, affective responses, prior experiences, and future objectives.

In addition, it needs to consider uncertainty, time-efficiency, and flexibility to be applicable in changing environments (Payne et al., 1993; Fellows, 2004). DM is somewhat arbitrarily divided into three sub-processes to facilitate research discussions (Fellows, 2004). At the first stage is information gathering and identification of alternative options. On the second stage is the evaluation and information processing. At this stage the decision-maker assesses a multitude of information such as context, hedonic valence, reward outcome, risk, and essentially produces a value for their available alternatives. The last stage is the action of choosing based on the preceding evaluation processes (Fellows, 2004).

Research on DM has resulted in two primary directions about how humans make decisions under uncertainty, namely rational and intuitive (Padilla et al., 2018). This dual processing is also reflected in the DM style one might have. Decision-making style refers to the learned, habitual and trait-like response patterns exhibited by individuals when confronted with a decision (Scott & Bruce, 1995; Geisler & Allwood, 2018; Driver et al., 1998). The term DM style has often been used in vocational literature (Scott & Bruce, 1995) but it is not limited to the field. DM styles are also tightly linked and indicatory of cognitive styles (Scott & Bruce, 1995; Thunholm, 2004), focusing on an individual's information, mental processes, and behavioral practices integral to decision-making. DM style has also been associated with information gathering patterns and information evaluation styles (Thunholm, 2004).

In healthy subjects, DM is a flexible and adjustable skill, making it applicable in multiple and varied scenarios (Payne et al., 1993; Cella et al., 2010; Mandelbaum & Buzacott, 1990; Fellows, 2004). It is well documented that DM process is highly sensitive to factors regarding the task at hand and the context (Payne et al., 1993). Correspondingly, DM is not limited to only one style. It is supported (Driver et al., 1998; Thunholm, 2004) that people often have a primary and a secondary style. Scot and Bruce (1995) also proposed that styles are not mutually exclusive, and a decision-maker may rely on more than one, while typically demonstrating a profile of combinations. Recent literature also supports that we are capable of dual processing, using both fast and slow thinking for DM depending on the situation (Padilla et al.; 2018, Payne et al., 1993).

DM styles have been investigated and evaluated with multiple tools, many of which overlap demonstrating a form of analytic and intuitive style. Noticing an obliquity in the field, Scott and Bruce directed their endeavors towards the integration of prior findings (Scott & Bruce, 1995). They identified a gap in existing DM style instruments to synthesize data based on earlier research. According to prior findings and large-scale studies conducted using different populations, five DM styles were identified and demonstrated on Table 1 (Scott & Bruce, 1995; Geisler & Allwood, 2018). The model was called the General Decision Making Style (GDMS), a widely used, valid and reliable tool (e.g. Loo, 2000; Curşeu & Schruijer, 2012) with several variations developed from the same and other researchers. In general, *rational* and *intuitive* have been associated with better decision-making performance, while the other three styles have been linked to more negative outcomes (Allwood & Salo, 2012; Bruine de Bruin et al., 2007; Geisler & Allwood, 2018). In this research paper we are using the GMDS as it is comprised of reoccurring styles found in prior literature and it captures much of the variation people display when making decisions.

General Decision Making Style	**Description**
Rational	Defined by information collection, inventory of alternatives, and systematic evaluation of available options.
Intuitive	Characterized by unsystematic information processing, hunches, and internal "gut" feelings, as well as attention to details and emotions.
Dependent	Demonstrates a need to seek external guidance or advice from others in order to make a decision.
Avoidant	Tries to avoid and evade DM situations completely (often lets others decide).
Spontaneous	Characterized by impulsive decision making and a desire to reach decision quickly.

Table 1. Definitions of Decision-Making Styles Used in This Study

Decision-Making in VR

Similarly to the real world, DM is a crucial skill for metaverse interactions as well. DM in VR has been researched in several contexts relating to morality (Skulmowski et al., 2014), aerial firefighting (Clifford et al., 2019), and emergency management (Beroggi et al., 1995). There is also research regarding consumer DM and extended realities (Qin et al., 2021; Xi et al. 2022), with indications of a more rational approach than non-VR-mediated conditions. There are also studies conducted for safety training (Leder et al., 2019), with participants immersed in VR environments demonstrating altered risk perception, by being less risk-aversive in their decisions and probability judgments compared to participants using traditional training means (Leder et al., 2019). Further studies have explored the effect of immersion on enhancing DM in team sports (Pagé et al., 2019) and found VR led to generalized and transferable gains in real life. There have also been serious VR games directed at the assessment of risk-taking regarding DM (De-Juan-Ripoll et al., 2020). And while we know data visualization can differentially influence DM (Padilla et al., 2018), not many studies have been conducted regarding financial data and 3D visualization in VR contexts, with few exceptions exploring prototypes (Lugmayr et al., 2019), or extended realities (XR) overall (Yuviler-Gavish et al., 2022).

Our research motivation is driven by several limitations in the current literature. To begin with, despite the plethora of studies surrounding DM been undertaken, especially in regards to training (e.g. Clifford et al., 2019; Beroggi et al., 1995; Leder et al., 2019; Pagé et al., 2019), there is an absence of research investigating daily metaverse dealings and incorporating financial interactions. It is likely that activities such as examining one's bank status or investments' progress will take place in the metaverse, and it is therefore important to explore similar realistic contexts. In addition, DM is situational and task-dependent, meaning it employs different strategies under diverse circumstances (Payne et al., 1993). To that end, the impact of immersion and self-motion on DM processes is currently unclear. A variety of findings have highlighted different aspects of DM in metaverse, such as decreased risk-aversion (Leder et al., 2019) or increased rational behavior (Xi et al. 2022). Consequently, there have been no studies examining the effects of immersion and motion on DM patterns or practices.

In this study we investigate if different immersive realities and different levels of embodiment using self-motion influence DM. To determine how immersive technologies may influence DM we designed an experiment manipulating immersion from low (PC monitor) to high (VR HMD); and sense of embodiment from low (self-anchored) to high (self-motion), compared to a control condition. We created a financial investing decision-making task and provided it to all groups before evaluating their DM style in each condition. Our results contribute to the better understanding of DM processes and provide feedback for future designs concerning finance-handling and motion requirements in the metaverse.

Methods

Participants

A total of 216 non-color-blind volunteers were recruited from Tampere University during July-November 2022. Thirty-three of them were used for pilot studies. Therefore 183 university students consisted this study's sample, with a mean age of 26.26 (18-48, *SD*=5.98)[1]. Ninety-two reported as male (50.3%), 88 as female (48.1%), and 3 as other (1.6%). The educational level of the students was 53% MSc, 38.3% BSc, 8.2% PhD, and 0.5% other. Most of the participants (80.9%) had no or very minimal VR experience. The cultural background varied from 44 countries, and over 60% of participants reported income less than 1000 € per month.

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[1] During MANOVA analysis, 2 outliers were identified and omitted from final sample.

Materials

Conditions & Design: We conducted a 2 (high immersion vs. low immersion) × 2 (self-motion vs. self-anchored) factorial experiment between-subjects, including a control group, to investigate decision-making styles in different virtual realities. PC monitor and VR HMD were used to provide low immersive experience and high immersive experience, respectively. The two levels manipulating sense of embodiment were free self-motion for high (physical movement and locomotion in VR, or using keyboard and mouse in monitor-mediated virtual environment), and being self-anchored for low (immovable from a preselected spot within the virtual environment, only able to examine the graph with key-binds of each device). Participants were shown a large 3D (or 2D for control) graph containing price and period information regarding 4 different financial assets. Each asset had a different color (Red, Blue, Yellow and Green), with prices changing across 29 periods (Figure 1). During a 10-minute experiment, participants had to explore their graph, collect information, evaluate their options, and make a decision. Depending on their condition, participants would stay in place and manipulate the graph using controllers or move themselves around (either physically or changing the view with keyboard and mouse). In the embodied condition (self-motion), participants were allowed to get contact with the graph and even be inside it. The financial tasks and the simply designed environment were considered relevant to daily life practices and cognitive computations.

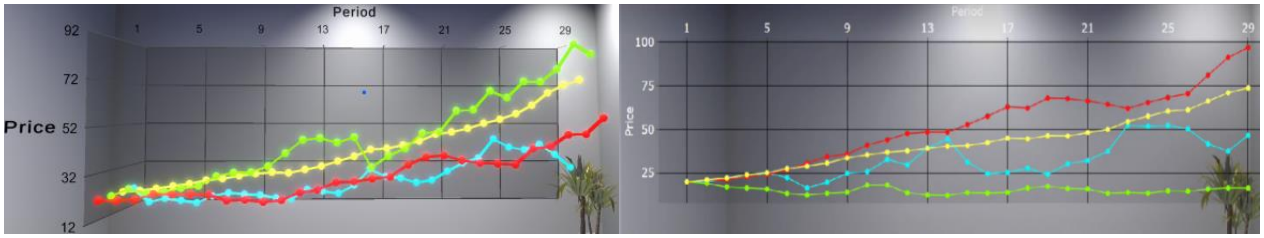


Figure 1. (Left) 3D Graph Employed in 4 Experimental Conditions. (Right) 2D Graph Employed Only in Control

Note. All graphs were randomly generated based on the same formula.

Measures: Data were primarily collected using online surveys via the Alchemer platform. Demographic information including age, gender, education, income etc. were acquired before the experiment. Decision-making style was measured using GDMS survey (Scott & Bruce, 1995) after the experiment was over. GDMS has five styles (Table 1), each measured by 5 items. We slightly adjusted these items from generic to specific, to inquire about the decisions made during the investment allocation task we provided, and participants completed during the experiment. For example, a *Spontaneous* item "*I generally make snap decisions*" turned to "*I made a snap decision*". Participants were instructed to complete each item stating their agreement level ranging from 1 = *Not at all*, to 7 = *Extremely*.

Experiment Task: Participants were shown a graph with 4 different colored assets and were able to interact with it for 10 minutes. During the first 5 minutes of the experiment participants were free to explore the presented graph and were then required to complete a series of tasks during the remaining 5 minutes. The main task in this study was to allocate 100% of an imaginary quota and make an investment portfolio with the aim of maximizing their returns and minimizing their risks. They could allocate their decided amounts in any one asset, or any asset combination, including the option for a bank deposit (Figure 2). To ensure all participants would try their best as in a real situation, their compensation was performance-based, while always receiving a minimum amount, regardless of performance.

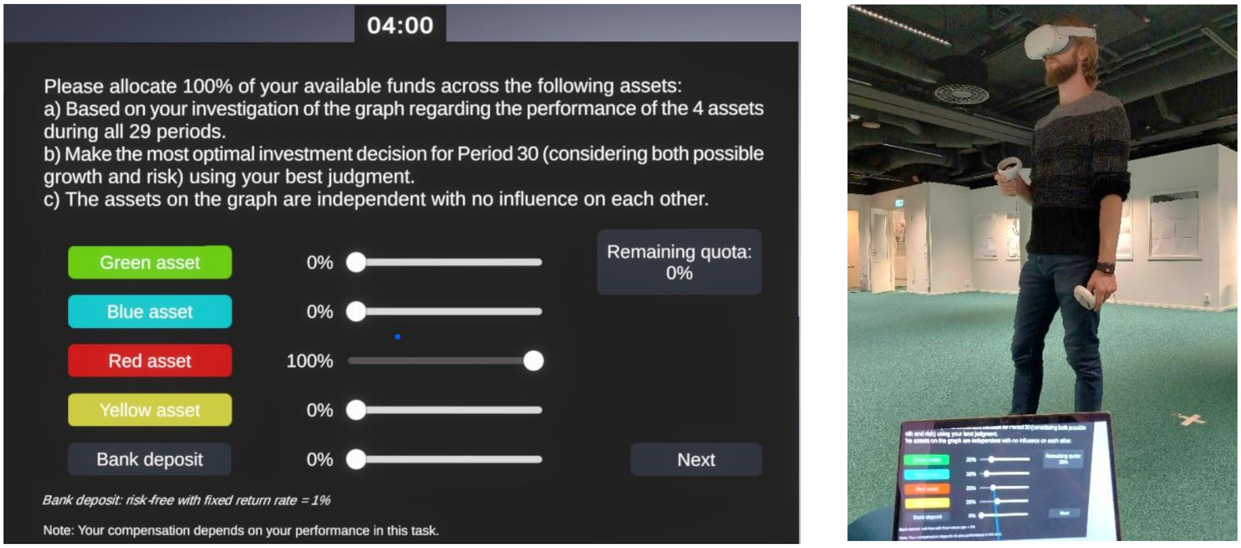
Physical Environments: The experiment was conducted in LUDUS laboratory located in Tampere University campus. For the high immersion conditions, we used a 6m×8m XR dedicated area (Figure 2). For low immersion and control conditions, we used a research cubicle located in the same laboratory. The cubicle was also used by all participants during GDMS survey completion after the experiment.

Virtual Environments: We developed a 3D virtual environment which remained the same for the four conditions and consisted of a simple room with a graph in its epicenter. The 2D control condition was based on a web-based application and depicted the same room as a background image (Figure 1). Interactions and information provided were maintained the same in all conditions, however the way of interaction would differ between conditions. In the embodied VR condition, participants could physically move (high sense of embodiment), while in the self-anchored VR condition participants had to rely on controllers to interact with 3D graph. For the low-immersion conditions (PC monitor-based) the interaction devices were different, but sense of embodiment was manipulated in a similar way: sense of self- motion vs. only moving the graph. A timer was also available on all conditions, including a notification when 5 minutes had passed to indicate to participants their financial tasks were now visible.

Devices: The high immersion conditions used a VR HMD Oculus Quest 2, 1832x1920 per eye, Qualcomm® Snapdragon™ XR2 Platform, 128GB, with its 2 touch controllers. The low immersion conditions employed a flat monitor screen AW2521HFLA (60 Hz, 1080p, 1920x1080, Fast IPS, 1ms response time, 24.5 inches), with a VOXICON DM-GR900 (800-12000 DPI) mouse, and a VOXICON DK-GR8-10 keyboard.

Procedure

University students were recruited via campus advertisements for a study regarding digitalized investing experience. All participants were pseudorandomized in one of the five conditions. Before the experiment, two experimenters responsible for all participants helped guide them through a tailored tutorial, specifically designed for each condition. The participants then received instructions about the experimental phase verbally and in text. After the first 5 minutes of exploration had passed, a series of tasks was to be completed within the remaining 5 minutes, with the graph always available to them. This study was based on an investment task requiring participants to allocate 100% of their imaginary quota (Figure 2). If the participant was not done once the 10 minutes were up, the system would prompt them to finish, and the platform would close to ensure everyone received the same amount of time. Participants were then guided to complete post-measures including the GDMS questionnaire regarding their performance on the investment allocation task. All participants provided consent in the beginning and received compensation in the form of digital grocery coupons upon completing the post measures. The study adhered to the Finnish National Board on Research Integrity TENK Guidelines 2019 and acquired research permission.



04:00

Please allocate 100% of your available funds across the following assets:
a) Based on your investigation of the graph regarding the performance of the 4 assets during all 29 periods.
b) Make the most optimal investment decision for Period 30 (considering both possible growth and risk) using your best judgment.
c) The assets on the graph are independent with no influence on each other.

Green asset	0%
Blue asset	0%
Red asset	100%
Yellow asset	0%
Bank deposit	0%

Remaining quota: 0%

Bank deposit: risk-free with fixed return rate = 1%

Note: Your compensation depends on your performance in this task.

Figure 2. (Left) The Decision-Making Allocation Task; (Right) Real Scene of Conducting the Task During Embodied VR Condition

Results and Analysis

Each item measuring a decision-making style was added to each other and divided by their total to generate five scores representing each of the styles for each participant. Descriptive statistics show that the overall highest Likert scale means were reported for *Rational* at 5.28/7, followed by *Dependent* 4.59, *Intuitive* 4.26, *Spontaneous* 3.65, and *Avoidant* 2.85, as reported in Table 2.

GDMS		**Rational**		**Intuitive**		**Dependent**		**Avoidant**		**Spontaneous**		
Immersion	**Embodiment**	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*N*
Control	Control	5.47	.542	4.19	1.183	4.60	1.217	2.77	1.393	3.39	.951	39
	Total	5.47	.542	4.19	1.183	4.60	1.217	2.77	1.393	3.39	.951	39
Monitor PC (low)	Self-anchored	5.33	.712	4.21	1.089	4.61	1.032	2.86	1.081	3.67	.886	36
	Self-motion	5.28	.813	4.37	1.090	4.53	1.292	2.83	1.264	3.79	1.103	35
	Total	5.30	.758	4.28	1.084	4.57	1.160	2.85	1.166	3.73	.993	71
VR HMD (high)	Self-anchored	5.08	.727	4.19	1.101	4.47	1.347	3.10	1.427	3.77	1.050	36
	Self-motion	5.23	.828	4.33	1.054	4.74	1.149	2.71	1.132	3.63	1.016	35
	Total	5.15	.776	4.26	1.072	4.60	1.252	2.91	1.295	3.70	1.028	71
Total		5.28	.731	4.26	1.096	4.59	1.202	2.85	1.262	3.65	1.002	181

Table 2. Descriptive Information of Five Decision Making Styles

A two-way MANOVA (multivariate analysis of variance) was conducted using SPSS. During pre-processing, two single factor extreme outliers were identified and removed from the final sample. Normality of GDMS according to Shapiro-Wilk was not assumed in all independent variable combinations. However, MANOVA is robust against normality violations, and all our groups are large and of similar size which further provides robustness to proceed with our analysis. We found no multicollinearity between the dependent variables; and all Mahalanobis values were below critical value, revealing no multifactor outliers. Both homogeneity of variances based on Levene's test, and Box's test of equality of covariance matrices were met with $p > .05$. The MANOVA was run with two levels of embodiment (low: self-anchored vs. high: self-motion) and two levels of immersion (low: PC monitor vs. high: VR HMD), and one control condition as the independent variables. All five GDMS including R*ational, Intuitive, Dependent, Avoidant,* and *Spontaneous* were placed as dependent factors. The results based on Pillai's trace showed no significant main effect of immersion ($F = .43$, $p = .82$), or embodiment ($F = .60$, $p = .69$) on decision-making style. There was also no significant interaction between the independent variables regarding decision-making style ($F = .76$, $p = .57$).

Discussion and Conclusions

The present study aimed to explore and understand how individuals make decisions in different virtual realities. To investigate that five conditions were designed based on different levels of immersion (low immersion vs. high immersion) and embodiment (self-motion vs. self-anchored) using a financial allocation task. Overall, the most common DM style used was *Rational*, followed by *Dependent, Intuitive, Spontaneous*, and *Avoidant* respectively. Our study indicates that *Rational* DM style was still prioritized in all virtual realities. Likely meaning participants still emphasized on the task at hand and approached it similarly to what we would expect in real life and to what we see in the control condition. We also see that the second most employed style was *Dependent*, which could be explained by the relatively young age of our participants. High scores of in *Dependent* are not too uncommon e.g Spicer & Sadler-Smith (2005), who consider participants not unable to make independent decisions, but keen on involving others with the consequent benefits of doing so. Even though we do not know how DM could be influenced under our independent variables and circumstances, it is worth noting that compared to conventional interactions (control group) our results indicate no negative influences on DM in virtual realities. There was no indication of favoring *Avoidant, Dependent,* or *Spontaneous* styles in any of the conditions, which have been associated with maladaptive performance in DM (Allwood & Salo, 2012; Bruine de Bruin et al., 2007; Geisler & Allwood, 2018). The mean scores of each DM style appear to be similar for each condition indicating no differences in how individuals make decisions within different virtual realities.

This is verified by the MANOVA results, revealing no main effect found from immersion or embodiment. While prior research indicates adaptability of DM to the situation, it is possible that in this case no such adaptation was invoked. There was no significant difference between participants who were moving freely in high immersion and embodiment, compared to those in control. It is possible that a prevailing factor participants considered the most, emphasized on the cognitive task for quota allocation based on previous experiences with similar problems, thus neglecting the situational environment of their condition, and the opportunities to employ a different strategy. Perhaps due to the time constrains and high reward prospects (performance-based compensation), participants did not want to approach the task in different ways and proceed with what felt familiar and safer. It is possible that if participants were more experienced with their system, they would employ differential styles, based on their experience and confidence of using it. It is also likely that if the stakes were lower, and consequently the design less realistic, participants would engage naturally to different patterns e.g. more playful behavior. This however was not the case, in fact participants rarely moved from the optimally viewing spot of the task instructions, even when motion was an option, likely due to the short time frame they had available to respond. Similar designs should consider allowing task management and accessibility throughout the environment e.g. information available at command, or pined on the top part of the viewing field, thus enabling the user with more freedom. Nevertheless, no differences were found during the low motion conditions either, where participants were always positioned to the most optimal viewing spot (for both the task and the graph), which could be manipulated using the respective controllers.

In conclusion, our findings indicate that individuals tend to follow the same DM patterns in metaverse as in real life. It is likely that metaverse interactions do not induce higher cognitive load, nor require more mental resources or differential processing to control. More importantly, there was no difference in the DM approach between virtual realities providing diverse levels of immersive and embodied experiences in realistic metaverse scenarios. Assuming the DM cognitive task is prioritized in the environment design, and the user remains focused and undistracted, we see no evidence that DM style would change in diverse virtual realities. However, it is worth mentioning again that DM is a flexible skill, and it is possible that other tasks or more emotional contexts may alter, consciously or not, DM behavior. Practitioners or industry could benefit by knowing immersion and motion are not detrimental influencers of DM, and therefore proceed, based on their needs, in an ethical way to the development of metaverse environments where users may conduct transactions. However, more research needs to be conducted examining realistic metaverse interactions and their effects on decision-making.

The contribution of this study is advancing our understanding of cognitive functions and behaviors in metaverse realities by empirically investigating DM. The experimental evidence provide valuable knowledge to the fields of human-technology interaction and information systems from a cognitive psychology perspective. In addition, the investigation on immersion and embodiment enriches the literature regarding technological and multisensory features of virtual environments, such as physical locomotion. Finally, the rigorous design and implementation of the laboratory experiment also provides useful methodological guidance for future research.

Limitations and Future Research

While GDMS was deemed the appropriate tool for this study, there are a few limitations stemming from its use. First, even though Scott & Bruce (1995) mention situations can affect DM choice style, the GDMS has been designed to investigate more steady traits defining DM, which are not necessarily as easily to be adjustable under different circumstances. Secondly, its items refer to more general statements about an individual's DM approach, which we slightly adjusted to reflect their investment task. Lastly, due to the nature of self-reported questionnaires it is always possible that the participants exhibited some unbeknownst biases in their responses. Another limitation of this study is that while our sample was large, it consisted solely of young adult students. Therefore, it is possible that different results could have been presented with a different group, making generalization of our findings limited. Future directions could look deeper into multisensory effects, such as olfaction, and investigate how the inclusion of multimodalities influence our perceptual and cognitive processes in relation to decision-making.

Acknowledgments

This work has been supported by the OP Ryhmän Tutkimussäätiö, under Grant No. 20200040 [INVESTUAL]; the Nasdaq Nordic Foundation [Promoting Financial Literacy and Pro-Environmental Choices Using Game-Based Pedagogy and Virtual Reality]; the KAUTE Foundation under Grant No. 20200531 [VIRTUMER]; the Academy of Finland Flagship Programme under Grant No. 337653 [UNITE | Forest-Human-Machine Interplay]; the Foundation for Economic Education under Grant No. 210301 [GAMETH]. This work was carried out with the support of LUDUS research lab in Tampere University, Finland. Special thanks to Ans Ahmad, Filipe Gama, Zampeta Legaki, Panu Kalmi, and Gökhan Buturak's contributions to the project. The authors would also like to extend their gratitude to all volunteer participants.

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