

Development and initial validation of the metaverse worry inventory

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Abstract. Concern over the rapidly evolving metaverse is growing, leading to the development of the "metaverse worry". Therefore, the purpose of this study is to develop an appropriate psychometric instrument to measure metaverse worry. The Metaverse Worry Inventory (MWI) was developed through two studies (N = 672). In Study 1, rigorous processes including item analysis, exploratory factor analysis and confirmatory factor analysis revealed two reliable factors for the 10-item inventory: negative belief and negative feeling. The MWI had excellent internal consistency (Cronbach's $\alpha = 0.89$) and medium test-retest reliability ($r = 0.62$). In study 2, good criterion-related validity of the MWI was confirmed by examining the MWI's relationship with intolerance of uncertainty and Big Five personality. The MWI captured the latent variables of metaverse worry and is essential for promoting metaverse development and alleviating worries.

1 Introduction

1.1 Why worry about the metaverse

The metaverse is a highly discussed topic in the wake of Web 3's development, conceived as a futuristic representation of an ideal human society. Initially, it was defined as a virtual world based on augmented reality (AR) and virtual reality (VR), as depicted in the cyberpunk novel *Snow Crash*. Users can create avatars and utilize them for various activities in the virtual world. Ball provides a specific definition that highlights the scale, interactivity, and continuity of the metaverse. It is described as a massively scaled and interoperable network of real-time rendered 3D virtual worlds that can be experienced synchronously and persistently by an unlimited number of users with a personalized sense of presence and continuity of data. Similarly, Hollensen et al. assert that the metaverse is a 3D world where business, information, and communication tools are immersive and interoperable.

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Over the past few decades, the metaverse has made significant contributions to society. However, as history has shown, the emergence of new technologies often leads to concerns and fears. Therefore, as the metaverse continues to evolve and gain traction, it is likely that concerns will arise surrounding its potential effects on society and individuals. The present study refers to this type of worry as "metaverse worry" (MW). The existence of metaverse worry is attributable to three specific reasons or three things that people might worry about regarding the metaverse. The monopoly of tech giants may be the first area of worry. Considering that the metaverse is the intersection of physical and virtual worlds, people will be required to wear VR headsets and other haptic devices to access this world. This creates the possibility for tech giants to exercise greater control over people's lives, which appears to contradict the metaverse's decentralized utopian vision. Data breaches represent the second possible threat. Privacy and security have been a concern since the inception of the internet several decades ago. And now the implementation of the metaverse could exacerbate this situation by further infiltrating people's daily lives and capturing an even greater amount of private information. However, the firms that own and control this data are not sufficiently protecting it from potential breaches and malicious attacks. The third area of concern is the rapid development of Artificial Intelligence (AI). As an essential infrastructure for the metaverse, AI has the potential to provide significant technical support across various areas such as big data analytics, digital creation, and intelligent deployment. However, while people are enjoying the benefits of technology, they also worry that AI may replace their jobs in the future. And this threat could potentially exacerbate the social class gap and amplify existing inequality issues.

1.2 Research purpose and significance

As the metaverse is projected to grow rapidly and attract more users, it is essential to understand their attitudes towards it, especially their worries. Therefore, the primary objective of this study is to develop a specialized metric to measure metaverse worry. To achieve this aim, we have created the Metaverse Worry Inventory (MWI). With the help of the MWI, we can identify the specific sources of worry that users may have regarding the metaverse. By understanding these concerns, technology companies can develop targeted interventions and strategies to address them and improve user satisfaction. This, in turn, will lead to better user acceptance of the metaverse and aid in the creation of a healthy and vibrant metaverse community that promotes positive user experiences.

2 Study 1: exploratory and confirmatory factor analysis

In the first study (The specific items and the detailed data results of study 1 and study 2 can be obtained by contacting the authors.), we conducted a comprehensive assessment of the Metaverse Worry Inventory (MWI) using a rigorous process. Initially, we developed an item pool for the MWI and conducted item analysis. Following this, we performed a series of exploratory factor analyses (EFA) and confirmatory factor analysis (CFA) to explore the dimensionality of the MWI. Through this process, we have established the reliability and construct validity of the MWI as a specialized tool for measuring metaverse worry.

2.1 Methods

2.1.1 Participants

There were two samples in the study. Sample 1 was used for EFA and contained 333

participants (158 males). The majority (77.8%) of the population was between the ages of 15 and 30, in the age range of 15 to 52 ($M = 25.00$, $SD = 6.08$). Sample 2 was used for CFA and consisted of 218 participants (113 males). The age range was 16 to 64 years old ($M = 23.56$, $SD = 5.26$).

2.1.2 Procedures

To obtain participants for our study, we utilized a voluntary sampling method and recruited all individuals online. Upon accessing the online questionnaire, each participant was presented with a brief introduction outlining the purpose of the study, estimated time commitment, and the meaning of the metaverse. Upon completion of the survey, each participant was compensated with a ¥1 reward, offered for an unlimited period. Furthermore, we guaranteed the confidentiality of the information collected and committed to using it solely for research purposes to maximize its effectiveness.

Both study 1 and study 2 were approved by the Human Research Ethics Committee of Southwest University (approval no.H23166). We certify that the studies were performed in accordance with the declaration of HELSINKI and later amendments.

2.1.3 Instruments Metaverse Worry Inventory (MWI)

The development of the item pool was based on the possible reasons for metaverse worry and literature review. According to Macleod et al. worry has three characteristics: (1) repetitive thoughts about an unclear future outcome; (2) the person's perception of the uncertain outcome as unwanted; and (3) such thoughts are unpleasant to experience subjectively. Our objective was to incorporate items that comprehensively captured the crucial elements of metaverse worry. Accordingly, we engaged two psychology experts to scrutinize the items and made modifications to improve the clarity and relevance of the items. Additionally, eleven psychology master students reviewed the items to evaluate their clarity, inclusivity, and face validity. Finally, there were 14 items in the initial version of the MWI, each item (e.g., "the future of the metaverse is very uncertain") was measured on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree).

2.2 Results

2.2.1 Item analysis

We analyzed descriptive information for all items in the MWI. As evidenced by the results, all items had approximately normal distributions, with skewness and kurtosis values between -1.5 and +1.5. All individual item and total score correlations were greater than 0.4 and significant, except for one item. And all facility indexes ranged from 20% to 80%. According to the results, all items performed very well. In summary, we removed one item during this process.

2.2.2 Factor structure and internal consistency of the MWI

Following confirmation that correlations between the majority of the items were greater than 0.30, measures of sampling adequacy (MAS) in the anti-image correlation matrix were all above 0.80, the Kaiser-Meyer-Olkin measure of sampling adequacy was 0.94, and

Bartlett's test of sphericity was significant ($p < 0.001$), a series of EFA were conducted using the principal components analysis (PCA) and the varimax-rotation method. We combined the well-known Kaiser criterion with the scree plot to determine the ideal number of factors. We deleted three cross-loaded (loading difference between factors was less than 0.20) items one at a time. In the end, a two-factor, 10-item solution that accounted for 66.30% of the variance was found. Factor 1, which accounts for 34.55% of the variation, illustrates the adverse effects that people believe the metaverse might bring about, named as negative belief. With factor 2 accounting for 32.19% of the variation, it depicts the unfavorable emotion of worry that people can experience and behavior that will be performed because of the metaverse, named negative feeling.

The Cronbach's alpha for the whole scale was 0.89, and for both subscales it was over 0.80, indicating excellent internal consistency for the MWI.

2.2.3 Construct validity: CFA Results of the MWI

Using the maximum-likelihood estimation method, a CFA was performed to see if the previously identified factors matched well with the independent sample. To minimize Type I and II errors, multiple fit indices were used, and the results indicated that the two-dimensional model demonstrated good model fit with the observed data: $\chi^2(34) = 83.93$, $p < 0.001$, CFI = 0.95, TLI = 0.94, RMSEA = 0.08, GFI = 0.93, NFI = 0.93. And all factor loadings were above 0.69, supporting the two-factor model comprised of negative belief and negative feeling. Based on these results, we defined metaverse worry as a kind of negative affect and negative thinking about potential threats from the metaverse. We also examined the test-retest reliability, and the Pearson correlation ($r = 0.62$, $p < 0.01$) indicated that the MWI has acceptable test-retest reliability. In addition, we performed paired t -tests. Results showed that the two-time total score did not differ significantly ($p = 0.54$).

3 Study 2: Criterion-related Validity

Study 2 set out to investigate the criterion-related validity of the MWI across time and samples. Based on previous literature, it was anticipated that metaverse worry would show (a) a moderate positive correlation with intolerance of uncertainty, (b) small negative correlations with extraversion, openness, conscientiousness, agreeableness, but a moderate positive correlation with neuroticism.

3.1 Methods

3.1.1 Participants

The sample comprised 205 participants (130 female) aged from 18 to 32 ($M = 21.56$, $SD = 2.35$).

3.1.2 Procedure

Most subjects were recruited through the internet using voluntary sampling, except for sample c in which 122 were students from Southwest University in Chongqing, China, recruited using convenient sampling.

Participants were asked to complete an online questionnaire. Similarly, we informed participants at the start of each questionnaire about the fundamental principles of the

metaverse, the purpose of the study, and that the data collected would only be used for this study. Each participant received ¥1 as compensation.

3.1.3 Instruments

Metaverse Worry Inventory (MWI). The 10-item Metaverse Worry Inventory.

The 10-item Big Five Personality Inventory (BFI-10). The ten items is assessed on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree). Cronbach's α was 0.69 for extraversion; 0.55 for agreeableness; 0.41 for conscientiousness; 0.52 for openness; and 0.58 for neuroticism.

The Intolerance of Uncertainty Scale-Short Form (IUS-12). Twelve items from the *Chinese version* of the IUS-12 were used to measure anxiety on a 5-point Likert scale (1 = not at all characteristics of me, 5 = entirely characteristic of me). A lower score implies a greater capacity to tolerate uncertainty. The Cronbach's α was 0.87.

3.2 Results

Results revealed that intolerance of uncertainty had medium positive correlations with overall metaverse worry and its two factors, neuroticism had small positive correlations with overall metaverse worry and negative belief. The other four personality traits were weakly and negatively correlated with overall metaverse worry and negative beliefs, except for agreeableness, which was not significantly correlated with overall metaverse worry. And the other factor, negative feeling, was not significantly associated with any of the five personality traits. In general, the results are consistent with our hypotheses and demonstrate good validity of the MWI.

4 Discussion

4.1 Interpretation of the metaverse worry inventory

In this article, we presented the scale development and validation processes of a new metaverse worry inventory. With the development of XR technology, the metaverse is no longer just a science fiction concept but is becoming a reality. Tech titans are jockeying for position in the metaverse and presenting a variety of proposals for its future, but no precise definitions and criteria have been widely acknowledged and admitted. There is a lot of uncertainty implied by the vagueness and openness, which could give rise to worries.

The initial version of the inventory for measuring metaverse worry (MWI) was produced through expert development and peer review. Subsequently, following a series of rigorous processes, we arrived at the final version of the MWI, which consists of ten items and two factors, with five items allocated to each factor. The first factor, which we termed negative belief, captures people's subjective perceptions of the threats associated with the metaverse. The second factor, negative feeling, reflects people's worrying emotions and corresponding behaviour in relation to the metaverse. Furthermore, the Metaverse Worry Inventory (MWI) has demonstrated high internal consistency, acceptable test-retest reliability, and good criterion-related validity.

4.2 Limitations and future studies

There are two limitations that need to be acknowledged regarding this study. Firstly, the final version of the MWI does not contain any negative items, which could have resulted in

the inability to effectively avoid response sets by participants. Secondly, the sample used in the study was restricted to subjects from China, which limits the generalizability of the findings to other cultural backgrounds. Further research is necessary to explore these cultural variations.

Further research could explore the psychometric properties of the MWI in more diverse samples. Moreover, the current MWI can serve as a fundamental instrument for psychological researchers to explore the metaverse topic. For instance, future studies could compare metaverse worry levels between individuals with GAD and those without, followed by an investigation into the pathological threshold of metaverse worry. This could potentially aid in the prevention and diagnosis of anxiety disorders.

5 Conclusion

In the present study, we developed a metaverse worry inventory. According to the results, metaverse worry is composed of two factors: negative belief represents people's perceptions about the potential hazards posed by the metaverse, while negative feeling represents worrisome feelings and accompanying behaviors. The inventory has good internal consistency and retest reliability. Furthermore, the scale's correlation coefficients with associated significant concepts imply that it has strong criterion-related validity.

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