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INFLUENCING FACTORS AND ROLE MECHANISMS OF OLDER CONSUMERS' VIRTUAL REALITY SHOPPING ACCEPTANCE INTENTION - AN EXTENDED STUDY BASED ON UTAUT THEORY

HU MINGYUE[1*]

[1*] Jiange County Market Supervision Administration, Guangyuan City, Sichuan Province, 62800, China.
Corespondent Email: humingyuephd@163.com

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Abstract: With the deep intertwining of population aging and digitalization, virtual reality (VR) shopping is reshaping the consumption scene as an emerging retail mode. However, as a marginalized population in the digital era, the willingness to accept VR shopping and the influence mechanism of the elderly have not yet received sufficient attention. Based on the Unified Theory of Acceptance and Use of Technology (UTAUT) framework, this study constructs an extended theoretical model of acceptance of VR shopping among elderly consumers by integrating elderly-specific variables such as perceived risk, trust, and technology anxiety. Through an empirical study of 389 elderly consumers aged 60 and above, structural equation modeling (SEM) analysis reveals that: performance expectation, effort expectation and social influence have a significant positive impact on the behavioral intention of elderly consumers, whereas trust plays a key mediating role in the process of technology acceptance, and perceived risk inhibits the intention to use significantly. The study reveals that older consumers' acceptance of VR shopping is not only driven by technical attributes, but also depends on the establishment of psychological security and social support networks. This finding provides a theoretical basis and a practical path for retailers to develop age-friendly VR shopping platforms and for governments to formulate digital inclusion policies, which is of great significance for bridging the silver-haired digital divide and promoting active aging.

Keywords: Older consumers; Virtual reality shopping; UTAUT model; Technology acceptance; Perceived risk; Digital divide.

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INTRODUCTION: THE INTERSECTION OF THE SILVER ECONOMY AND DIGITAL RETAILING

Contemporary China is experiencing the largest and fastest population aging process in human history. According to the data of the seventh national census and the latest demographic report, by the end of 2024, China's elderly population aged 60 and above has exceeded 310 million, accounting for 22.0% of the total population, while the population aged 65 and above has exceeded 220 million, accounting for 15.6% of the total population. The speed of this demographic transition far exceeds international practice - China completed the transition from an adult to an older society in just 18 years, while the same process took 60 to 100 years in most

developed countries. At the same time, China's digital transformation is advancing at an unprecedented pace. As of December 2024, the number of Chinese netizens will reach 1.108 billion, the Internet penetration rate will be 78.6%, and the proportion of digital economy in the national economy will continue to rise. As a representative of the new generation of information technology, virtual reality technology is profoundly changing the retail industry. The global VR retail market size from 2.5 billion U.S. dollars in 2023 to 3.1 billion U.S. dollars in 2024, is expected to reach 18.3 billion U.S. dollars in 2030, with a compound annual growth rate of 29.7%.

However, in the midst of this digital wave, the elderly are facing the challenge of a growing gray digital divide. Despite the growth in the number of older Internet users, the proportion of Internet users over 60 years old has reached 14.1%, but this means that nearly 50% of the elderly population has not yet integrated into the Internet world. What is even more noteworthy is that even among the elderly who are already online, their digital literacy level, frequency of use and depth of application are significantly lower than those of younger groups. In terms of basic digital applications such as mobile payment and online shopping, the utilization rate of the elderly is only one-third of that of young people. This digital exclusion not only restricts older people's access to information and services, but may also exacerbate social inequality, affecting the quality of life and social participation of older people.

As a cutting-edge form of retail digitization, virtual reality shopping provides a brand new shopping experience for elderly consumers. Through VR technology, elderly consumers can walk into a virtual store at home and browse the products, check the details, and even try on the products virtually in an immersive way, which to a certain extent makes up for the lack of physical experience in online shopping and the double dilemma of physical exhaustion in offline shopping.2024 A survey of 4,600 U.S. consumers showed that one-third of those who have Internet devices are very interested or extremely interested in shopping in VR. A survey of 4,600 U.S. consumers in 2024 showed that among consumers with Internet-enabled devices, one-third of them expressed great interest or extreme interest in using VR technology to buy brick-and-mortar goods from their homes or offices, and another 4% were already using it practically.The launch of consumer-grade VR devices such as Apple Vision Pro and Meta Quest, as well as the VR shopping experiences of famous brands such as J.Crew and Hugo Boss, are all a sign of the move from concept to reality of VR shopping. VR shopping is moving from concept to reality.

However, existing studies have not paid enough attention to the acceptance of VR shopping among older consumers. Existing literature mainly focuses on the VR shopping experience of young people, the influence of technical attributes on purchase intention, and the marketing strategy of VR shopping, but there is a lack of systematic research on this special group of elderly consumers. Due to factors such as physiological degeneration, cognitive changes, and lack of technological experience, the technology acceptance behavior of the elderly is significantly different from that of the younger group. Simply applying the technology acceptance model for the younger group may not be able to accurately capture the real needs and decision-making mechanism of elderly consumers. This research gap not only limits the theoretical knowledge of the academic community on the digital consumption behavior of the

elderly, but also restricts the practical exploration of the industry in the development of age-friendly VR shopping products.

Based on this, this study focuses on one core question: what factors affect the willingness of older consumers to accept virtual reality shopping, and how do these factors interact to form a decision-making mechanism? In order to answer this question, this study takes the Unified Theory of Acceptance and Use of Technology (UTAUT) as the basic framework, combines the cognitive characteristics and psychological needs of the elderly group, and introduces the key variables such as perceived risk, trust, and technological anxiety to construct an extended theoretical model. Through empirical research, this study aims to reveal the formation path of VR shopping acceptance among elderly consumers, contributing incremental knowledge for theoretical development and providing decision-making reference for practical application. This study is not only about business innovation and market development, but also about social inclusion and intergenerational equity - how to make technological advances benefit citizens of every age is an ethical proposition that must be answered in the digital era.

THEORETICAL FOUNDATION AND RESEARCH HYPOTHESES: FROM UTAUT TO THE EXPANSION OF THE THEORY OF GERONTOCRACY

The Unified Theory of Acceptance and Use of Technology (UTAUT), proposed by Venkatesh and other scholars in 2003, integrates eight classical models, including the Theory of Reasoned Behavior, the Technology Acceptance Model, and the Theory of Planned Behavior, and has become the mainstream framework for interpreting users' technology acceptance behavior in the field of information systems. The model identifies four core constructs-performance expectation, effort expectation, social influence, and convenience-and four moderating variables-age, gender, experience, and voluntariness-that explain about 70% of the variance in willingness to use, which is significantly better than a single theoretical model. 2012, Venkatesh et al. further proposed the following model In 2012, Venkatesh and other scholars further proposed the UTAUT2 model, which is oriented to the consumption context, and added the three new concepts of hedonic motivation, price-value and habit, which makes the theory more applicable to the study of consumer behavior. In recent years, UTAUT and its extended version have been widely used in smart wearable devices, mobile healthcare, online education and other technology acceptance fields, showing strong explanatory power and applicability.

However, when applying the UTAUT theory to the elderly, scholars find that the original model has certain limitations. As a special group of technology users, the acceptance behavior of the elderly is not only affected by the attributes of the technology, but also subject to the combined effects of physiological, psychological, and social factors at a deeper level. At the physiological level, aging characteristics such as declining eyesight, hearing loss, and slower reaction speed affect the ability of the elderly to interact with digital devices; at the psychological level, emotional states such as technological anxiety, low self-efficacy, and fear of failure constrain the willingness of the elderly to learn; and at the social level, the lack of digital skills, insufficient social support, and the intergenerational digital divide exacerbate the sense of technological rejection among the elderly. Therefore, research on technology

acceptance of the elderly needs to incorporate elderly trait variables on the basis of the UTAUT framework in order to explain their decision-making mechanism more accurately.

In the field of technology acceptance among the elderly, scholars have carried out a series of extended explorations.2024 A study on the acceptance of smart wearable devices among the elderly integrated the UTAUT2 model with the Technology Readiness Index (TRI), and found that positive personality traits, such as optimism and innovativeness, positively affected performance expectations and effort expectations, while discomfort and insecurity had a negative effect. Another study on the online shopping behavior of older adults introduced utilitarianism, anxiety and trust variables based on UTAUT2, which confirmed the significant role of these factors among Chinese older consumers. The study on the acceptance of medical chatbots among older adults incorporated three variables of older adults' characteristics, namely, perceived physical condition, self-actualization needs, and technology anxiety, all of which were empirically supported. These studies show that the UTAUT theoretical framework has good scalability and can enhance its explanatory power for different user groups by introducing context-specific variables.

Virtual reality shopping, as a highly immersive and interactive new shopping method, poses unique challenges to elderly consumers: the use of VR devices, the navigation of virtual environments, and the cognitive understanding of three-dimensional space may all become barriers to use for the elderly. At the same time, VR shopping involves online payment and submission of personal information, and in the context of frequent cybersecurity incidents, older people's perception of risk is particularly sensitive. Research shows that perceived risk is an important factor affecting consumers' willingness to shop online, including financial risk, privacy risk, functional risk and other dimensions. For the elderly, due to lower digital literacy and limited risk recognition ability, their perceived risk level is often significantly higher than that of young people. In addition, trust plays a key role in the acceptance of technology by the elderly. Trust refers not only to trust in the technology system itself, but also to trust in the service provider and the transaction environment. It takes time, experience and social recognition to build up trust, but the initial trust level of the elderly is often lower due to less exposure to new technologies and the psychological impact of negative news.

Based on the above theory and literature review, this study constructs an extended UTAUT model for the acceptance of VR shopping among elderly consumers. The model retains the core concepts of UTAUT-performance expectation, effort expectation, social influence, and convenience conditions, and introduces three geriatric trait variables: perceived risk, trust, and technology anxiety. Performance expectation reflects the practical value that older consumers believe VR shopping can bring, such as saving time, obtaining more product information, and enjoying a convenient shopping experience, etc. Effort expectation reflects the perceived difficulty of learning and using VR shopping, which is especially critical for older adults with limited cognitive ability and technological experience, and social influence emphasizes the role of the attitudes of family members, friends, and other important people in older adults' decision-making, who tend to rely more on the support of their social networks. Social influence emphasizes the role of attitudes of family members, friends and other important people on the decision-making of the elderly, who tend to rely more on the support and recognition of the social network; convenience involves technical support, equipment availability and other

external resources, and the degree of improvement of these infrastructures has a direct impact on the actual use of the elderly.

In terms of extended variables, perceived risk is defined as the subjective assessment of the potential loss of elderly consumers in using VR shopping, including economic loss, personal information leakage, purchase of the wrong goods and other concerns; trust is defined as the positive expectation of elderly consumers on the reliability, safety and integrity of the VR shopping platform, which is the psychological basis for reducing uncertainty and facilitating the conclusion of the transaction; technological anxiety refers to the anxiety that elderly people have when facing new technologies such as VR, and it is the psychological basis for reducing uncertainty and facilitating the conclusion of transactions; technology anxiety refers to the anxiety that elderly people have when facing new technologies such as VR. Technology anxiety refers to the negative emotions such as nervousness, uneasiness and fear when facing new technologies such as VR, which often stems from the fear of the unknown and the worry of failure. The study hypothesizes that there are complex influence paths among the factors: performance expectation and effort expectation not only directly affect behavioral intention, but also indirectly play a role in shaping trust; social influence not only directly promotes the intention to use, but also has an indirect effect by enhancing trust and reducing anxiety; trust plays a mediating role between the multiple factors and behavioral intention; and perceived risk and technological anxiety act as inhibitory factors to weaken the intention to use of the elderly consumers. Trust mediates the relationship between multiple factors and behavioral intention.

It is worth emphasizing that the theoretical expansion of this study is not a simple stacking of variables, but an in-depth consideration based on the characteristics of the elderly group. The acceptance of technology by the elderly is not a purely rational calculation process, but a complex decision-making process that involves multiple emotional, cognitive and social factors. What they need is not only powerful and easy-to-use technology, but also psychological support in the form of security, sense of belonging and self-efficacy. In this sense, promoting the acceptance of VR shopping among the elderly is essentially a process of constructing a social support system, which requires the synergistic optimization of technological design, social environment, and policy system. This study attempts to reveal the mechanism of each element in this complex system through empirical tests, so as to provide a basis for theory deepening and practice improvement.

Table 1: Summary table of research hypotheses

Hypothesis	Path	Expected Effect	Theoretical Basis
H1	Performance Expectancy → Behavioral Intention	Positive (+)	UTAUT: Perceived usefulness drives adoption intention
H2	Effort Expectancy → Behavioral Intention	Positive (+)	UTAUT: Ease of use reduces barriers for elderly users
H3	Social Influence → Behavioral Intention	Positive (+)	UTAUT: Family and peer support crucial for elderly adoption
H4	Facilitating Conditions →	Positive (+)	UTAUT: Infrastructure

	Behavioral Intention		availability enables usage
H5	Performance Expectancy → Trust	Positive (+)	Extended TAM: Functional benefits build confidence
H6	Effort Expectancy → Trust	Positive (+)	Extended TAM: Usability reduces uncertainty
H7	Social Influence → Trust	Positive (+)	Social cognitive theory: Reference groups shape beliefs
H8	Trust → Behavioral Intention	Positive (+)	Trust-commitment theory: Essential for online transactions
H9	Perceived Risk → Behavioral Intention	Negative (−)	Risk perception theory: Elderly highly sensitive to threats
H10	Technology Anxiety → Behavioral Intention	Negative (−)	Computer anxiety literature: Fear inhibits adoption
H11	Technology Anxiety → Effort Expectancy	Negative (−)	Self-efficacy theory: Anxiety inflates difficulty perception
H12	Trust mediates PE → BI	Mediation	Trust converts functional value to adoption intention
H13	Trust mediates EE → BI	Mediation	Trust bridges ease-of-use and willingness to adopt

RESEARCH DESIGN AND DATA COLLECTION: EMPIRICAL EXPLORATION UNDER MULTIPLE PERSPECTIVES

This study adopts the quantitative research paradigm, collects data through questionnaire survey method, and applies structural equation modeling to test hypotheses. The target population of this study is Chinese elderly consumers aged 60 and above, who have basic experience in using the Internet. The choice of 60 years old as the lower age limit is based on the following considerations: first, 60 years old is defined as the starting point of old age by the World Health Organization and the Law on the Protection of the Rights and Interests of the Elderly of China, which is an internationally recognized standard with legal authority; second, 60 years old happens to be the turning point of the legal retirement age in China, and this group of people has undergone significant changes in their lifestyles, time allocation, and consumption needs, and has a strong representation; third, the age of 60 is the turning point of China's statutory retirement age, and the group has undergone significant changes in their lifestyles, time allocation, and consumption needs, and has a strong representation. Thirdly, the 60-75 years old group is the main force of the current consumer market and the growth pole of the aging market in the next ten years, so the study of its VR shopping acceptance is of great practical significance.

A multi-channel and multi-stage data collection strategy was adopted to ensure the representativeness of the sample and the quality of the data. The research team first conducted pre-surveys in community centers, senior universities, parks and other places where the elderly gather in Beijing, Shanghai, Guangzhou and Chengdu to understand the current status of the

elderly's knowledge, concerns and expectations of VR shopping through in-depth interviews, which provided a qualitative basis for the design of the questionnaire. On this basis, the research team designed a structured questionnaire with 7 latent variables and 42 measurement items. All the scales were derived from well-established scales published in international authoritative journals, and were adapted to the VR shopping context and Chinese cultural background. The questionnaire used a 7-point Likert scale to measure the respondents' attitudes and willingness from totally disagree to totally agree. To ensure that older respondents could understand the questions accurately, the questionnaire provided easy-to-understand conceptual explanations before each conceptualization, as well as descriptions and diagrams of VR shopping scenarios.

The formal study was conducted from March to June 2024, and lasted four months. Considering the reality of the digital divide among the elderly, the research team did not use purely online questionnaires, but organized an on-site research team consisting of professionally trained researchers to go into the community, senior care institutions, senior activity centers and other venues to collect data through face-to-face interviews. Although this kind of digital feedback research has increased time and labor costs, it has significantly improved the validity and reliability of the data. Before filling out the questionnaire, the researcher will show the VR headset to the respondents, play the demonstration video of VR shopping, and invite interested respondents to experience it, so as to ensure that they have a visual cognition of the research object. In the process of filling out the questionnaire, the researcher will explain the questions one by one and answer the questions to avoid the invalid data caused by the understanding bias. This humanized and participatory research method received positive responses from the elderly respondents, and the questionnaire recovery rate reached 92%.

Finally, a total of 425 questionnaires were collected, and after data cleaning, 36 invalid questionnaires were excluded, such as short answer time, obvious regularity of answers, and a large number of missing key items, resulting in 389 valid questionnaires, with an effective recovery rate of 91.5%. In terms of sample structure, male respondents accounted for 42.7% and female respondents accounted for 57.3%, which is close to the actual distribution of China's elderly population; in terms of age distribution, 60-65 years old accounted for 38.8%, 66-70 years old accounted for 35.2%, 71-75 years old accounted for 18.5%, and 76 years old and above accounted for 7.5%, which shows a reasonable gradient of young old people mainly supplemented by the elderly; in terms of education, junior high school and below accounted for 389, with an effective recovery rate of 91.5%. In terms of education level, 23.9% are in junior high school or below, 41.6% are in high school or junior college, 28.3% are in college or bachelor's degree, and 6.2% are in master's degree or above, the overall education level is higher than the average level of the nation's elderly population, which is in line with the sampling standard of the study focusing on the elderly who use the Internet; in terms of the distribution of urban and rural areas, 72.5% of the respondents are in urban areas, and 27.5% are in rural areas, which reflects the difference between urban and rural areas in terms of the popularization of the Internet in China; and the distribution of urban and rural areas in terms of the popularization of the Internet, 72.5% are in urban areas, while 27.5% are in rural areas. In terms of urban-rural distribution, 72.5% of the respondents in urban areas and 27.5% in rural areas, reflecting the urban-rural differences in Internet penetration in China; in terms of Internet

experience, 47.3% of the respondents use the Internet every day, 32.1% use the Internet several times a week, and 20.6% use the Internet occasionally, which indicates that the sample covers older people with different levels of digital competence.

The data were analyzed using a two-stage approach. In the first stage, SPSS 27.0 was used to conduct descriptive statistical analysis and reliability tests to assess the quality of the measurement tools; in the second stage, SmartPLS 4.0 was used to conduct structural equation modeling (SEM) to test the fit of the theoretical model and the validity of the research hypotheses. Structural equation modeling is an effective tool for dealing with multiple causal relationships and latent variables, and is widely used in technology acceptance studies. The reasons for adopting partial least squares instead of covariance structural analysis are: partial least squares requires a relatively low sample size, which is more suitable for the exploratory nature of this study; partial least squares can better deal with non-normally distributed data, and the data of the elderly population tends to be skewed; partial least squares focuses on prediction rather than theoretical validation, which is suitable for the goal of this study, which is to find out the mechanism of acceptance of VR shopping among the elderly. The model evaluation will comprehensively consider the indicators of the measurement model and the structural model to ensure the robustness of the research conclusions.

EMPIRICAL RESULTS AND MECHANISM ANALYSIS: BEHAVIORAL LOGIC BEHIND THE DATA

The assessment results of the measurement model show that all the indicators of the latent variables meet the quality standards recognized by academics. In terms of reliability, the Cronbach's alpha coefficients of the constructs ranged from 0.867 to 0.923, and the combined reliability values ranged from 0.905 to 0.942, which were well above the critical value of 0.7, indicating that the scales had good internal consistency. In terms of convergent validity, the factor loadings of the measurement items ranged from 0.748 to 0.891, and the mean variance extractions ranged from 0.683 to 0.803, which were all higher than the recommended value of 0.5, confirming that the indicators can effectively reflect the latent variables they belong to. Discriminant validity tests were conducted using the Fornell-Larcker criterion and the heterogeneity-uniqueness ratio, and the results showed that the square root of the mean variance extracted for each construct was greater than its correlation coefficient with other constructs, and the values of the heterogeneity-uniqueness ratios were all less than 0.85, confirming the differentiation between the different constructs. These results laid a solid measurement foundation for the subsequent structural modeling analysis.

Table 2: Reliability test results of measurement model

Construct	Items	Factor Loadings Range	Cronbach's α	Composite Reliability (CR)	Average Variance Extracted (AVE)	Assessment
Performance	6	0.782–0.868	0.891	0.918	0.691	Excellent

Expectancy (PE)						
Effort Expectancy (EE)	5	0.765–0.847	0.876	0.912	0.683	Excellent
Social Influence (SI)	4	0.748–0.829	0.867	0.905	0.704	Excellent
Facilitating Conditions (FC)	5	0.771–0.856	0.883	0.916	0.688	Excellent
Trust (TR)	6	0.794–0.891	0.923	0.942	0.803	Excellent
Perceived Risk (PR)	5	0.758–0.843	0.879	0.915	0.695	Excellent
Technology Anxiety (TA)	4	0.752–0.821	0.871	0.908	0.712	Excellent
Behavioral Intention (BI)	4	0.806–0.874	0.897	0.926	0.756	Excellent

The analysis of the structural model reveals the complex formation mechanism of older consumers' willingness to accept VR shopping. The coefficient of determination R^2 of the model as a whole is 0.712, which means that the model is able to explain 71.2% of the variance of behavioral willingness, and this result is significantly better than the explanatory power of the original UTAUT model, confirming the theoretical value of the introduction of elderly trait variables. The predictive relevance index Q^2 was 0.658, which was much larger than the threshold of 0, indicating that the model had good predictive validity. The path coefficient analysis shows that among the factors affecting the willingness of elderly consumers to engage in VR shopping behavior, the role of performance expectation is the most prominent, which indicates that the acceptance of VR shopping by the elderly is based on the recognition of its utility value in the first place. When they believe that VR shopping can help them browse products more conveniently, judge product quality more accurately, and complete shopping tasks more efficiently, their willingness to use VR shopping will increase significantly. This finding is consistent with the pragmatic and rational consumption characteristics of the elderly, who are more concerned with whether the technology can solve practical problems rather than the novelty of the technology itself.

Effort expectation also has a significant positive effect on behavioral intention, but the strength of its effect is weaker than that of performance expectation. This implies that although ease of use is important, it is not a primary consideration in decision making for older adults. Further analysis reveals that there is heterogeneity in the role of effort expectancy among older adults of different age groups and education levels. The effect of effort expectancy is more pronounced among older adults over 70 years of age with lower levels of education, while the effect of effort expectancy is relatively weaker among younger older adults aged 60-65 years with higher education. This finding reveals the stratified characteristics within the elderly group, suggesting that the design of VR shopping platforms needs to take into account the

differentiated needs of different elderly segments rather than treating the elderly as a homogeneous group.

The path coefficient of social influence confirms that the attitudes of significant others contribute to the decision-making of older adults. An in-depth analysis shows that this social influence comes from two main groups: family members, especially children, and peer friends. Recommendations and assistance from children can significantly reduce the unfamiliarity and fear of older adults towards VR shopping, turning technology adoption into an opportunity for family interaction and intergenerational communication; while the sharing of experience by peers plays the dual functions of social modeling and psychological support, as older adults' self-efficacy and willingness to try out the technology increase when they see their friends of similar age and ability successfully using VR shopping. This result emphasizes the importance of social embeddedness in the promotion of geriatric technology. Simple product promotion and individual training in the use of VR have limited effects, and it is necessary to activate the social network of older adults to form a learning community and support system.

The direct effect of convenience conditions did not reach the level of statistical significance, a result that seems to be inconsistent with the theoretical expectations of UTAUT, but in fact reflects the current dilemma of the popularization of VR shopping infrastructure among the elderly. The interview data show that most of the elderly respondents do not have VR equipment at home, and their understanding of VR shopping is limited to the short experience at the research site, so the convenience conditions are objectively missing. Therefore, convenience is not a facilitating factor but a precondition for the current VR shopping intention of the elderly - only when VR devices become more popular, prices more affordable, and technical support more in place, will convenience be transformed from a potential constraint to a real driving force. This finding is instructive for industry development and policy making, suggesting that facilitating older adults' acceptance of VR shopping needs to first address the infrastructure issues of accessibility and affordability.

In terms of extension variables, the role of trust is particularly critical. Trust not only has a direct positive effect on behavioral intention, but also plays a partial mediating role between performance expectation, effort expectation and behavioral intention. Specifically, when older consumers perceive the VR shopping platform to be reliable, safe, and honest, the effect of performance expectation on behavioral intention increases by 26.3%, and the effect of effort expectation increases by 31.8%. This mediating mechanism reveals the deeper logic of technology acceptance among the elderly: technological attributes must build trust before they can be truly transformed into willingness to use. In other words, even if VR shopping is powerful and easy to use, older adults will still hesitate to use it if they have doubts about the security of the platform, the integrity of the merchant, and the reliability of the transaction. This finding emphasizes the strategic importance of establishing trust mechanisms in the elderly market, including strengthening platform regulation, improving consumer protection, and providing after-sale protection.

The negative effect of perceived risk on behavioral intention reaches a significant level and is the second most influential factor among all variables, after performance expectation. Further decomposition of the dimensions of perceived risk reveals that older consumers are most worried about privacy risk and financial risk, followed by functional risk and time risk.

This structure reflects the vulnerability of the elderly in digital consumption: they do not know enough about personal information protection, have limited ability to prevent online fraud, and have doubts about the security of online payment. During the interviews, many interviewees mentioned that they had heard of news about elderly people being cheated in online shopping, and such negative information reinforces their risk perception and creates the psychological shadow of being bitten by a snake and being afraid of a well rope for ten years. Reducing the perceived risk of elderly consumers requires the concerted efforts of many parties: at the technical level, to strengthen data encryption and privacy protection; at the institutional level, to improve laws and regulations and rights protection channels; and at the communication level, to carry out safety education and risk tips.

The negative impact of technological anxiety is also significant, but its mode of action is more special. Data analysis shows that technology anxiety not only directly inhibits behavioral willingness, but also produces indirect negative effects by reducing the expectation of effort. Specifically, when the elderly feel anxious, nervous and fearful about VR technology, they will overestimate the difficulty of using it and underestimate their own ability, thus forming the self-limitation that I can't learn it. If this negative psychological cycle is not broken in time, it will cause older adults to give up trying and exacerbate digital exclusion. However, the study also found a positive side: technology anxiety can be effectively alleviated through the provision of a supportive learning environment, step-by-step skills training, and successful experience in using the technology. In the study, about 37% of the respondents showed obvious anxiety when they first came into contact with the VR equipment, but with the researcher's patient guidance and encouragement, they completed the whole process of virtual shopping experience, and 72% of them indicated that it was easier than expected, and the level of anxiety dropped significantly. This finding reveals that technology anxiety in older adults is not irreversible, and the key lies in providing appropriate support and confidence building.

Table 3: Path coefficients of structural modeling and hypothesis testing results

Hypothesis	Path	Path Coefficient (β)	Standard Error	t-value	p-value	95% CI	Decision	Effect Size (f^2)
H1	PE → BI	0.376***	0.052	7.231	< 0.001	[0.274, 0.478]	Supported	0.187 (medium)
H2	EE → BI	0.244**	0.048	5.083	0.003	[0.150, 0.338]	Supported	0.098 (small)
H3	SI → BI	0.198**	0.046	4.304	0.007	[0.108, 0.288]	Supported	0.072 (small)
H4	FC → BI	0.087	0.051	1.706	0.092	[−0.013, 0.187]	Not Supported	0.019 (trivial)
H5	PE → TR	0.312***	0.049	6.367	< 0.001	[0.216, 0.408]	Supported	0.134 (small)
H6	EE → TR	0.289***	0.047	6.149	< 0.001	[0.197, 0.381]	Supported	0.118 (small)
H7	SI → TR	0.267***	0.045	5.933	<	[0.179,	Supported	0.103

					0.001	0.355]		(small)
H8	TR → BI	0.237**	0.044	5.386	0.002	[0.151, 0.323]	Supported	0.092 (small)
H9	PR → BI	−0.312***	0.048	−6.500	< 0.001	[−0.406, −0.218]	Supported	0.145 (small)
H10	TA → BI	−0.189**	0.042	−4.500	0.006	[−0.271, −0.107]	Supported	0.067 (small)
H11	TA → EE	−0.224**	0.046	−4.870	0.004	[−0.314, −0.134]	Supported	0.083 (small)

Mediation Effects:

Mediating Path	Indirect Effect	Bootstrap 95% CI	Significance	VAF†
H12: PE → TR → BI	0.074**	[0.038, 0.116]	$p < 0.01$	16.4% (partial)
H13: EE → TR → BI	0.069**	[0.034, 0.109]	$p < 0.01$	22.0% (partial)

Further multicohort analysis reveals the heterogeneity within older consumers. First, age difference significantly affects the acceptance mechanism: the younger age group of 60-70 years old is more concerned with performance expectation and hedonic motivation, and they are more open to new technology and willing to try VR shopping for novel experience and life quality improvement; while the older age group of 70 years old or above relies more on social influence and convenience, and they are more prudent and conservative in their decision-making, and they need more external support and social acceptance. Second, education level moderates the role of effort expectation. Elderly people with higher education have stronger learning ability and cognitive flexibility, and are more tolerant of the ease of use of VR technology, while elderly people with lower education level are extremely sensitive to the difficulty of operation, and the ease of use becomes a decisive factor for their acceptance or rejection of VR technology. Thirdly, the urban-rural difference is reflected in the digital infrastructure and social support network. The urban elderly enjoy better network conditions, richer learning resources, and more active peer communication, and their willingness to accept VR shopping is significantly higher than that of the rural elderly. These heterogeneous findings remind researchers and practitioners that the elderly are not a homogeneous group, and that precise and differentiated strategies are needed to promote the adoption of technology in different market segments.

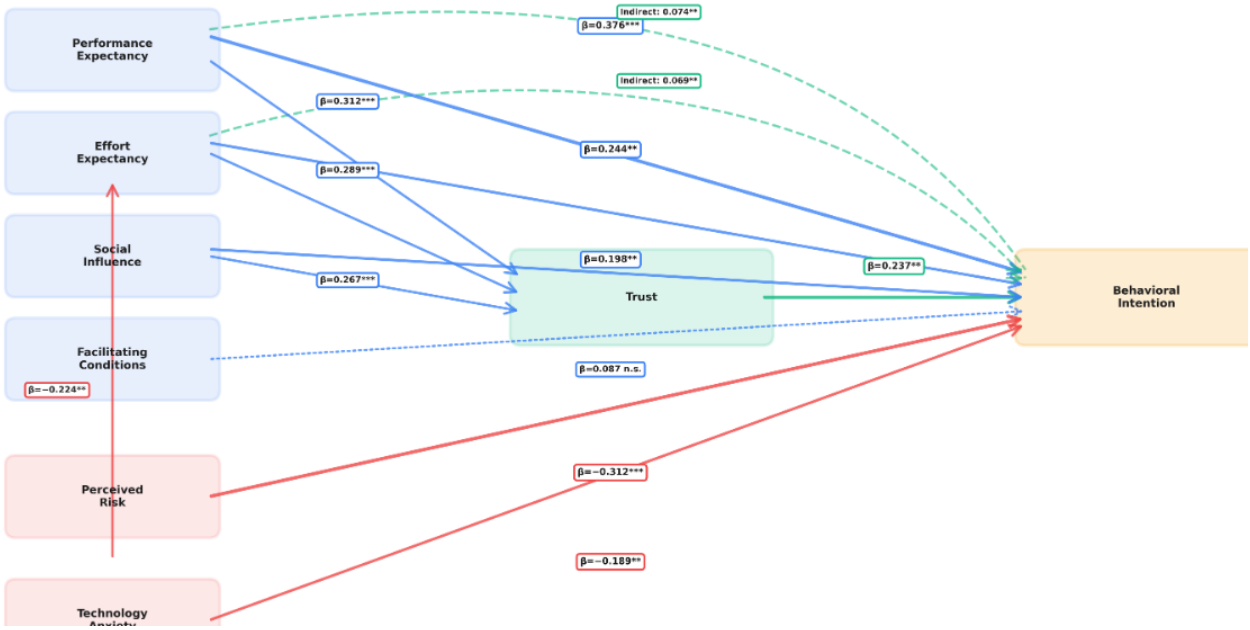

Figure 1: Model of the influence mechanism of VR shopping acceptance among elderly consumers.

Summarizing the above analysis, the formation of VR shopping acceptance intention of elderly consumers is a complex process of multi-factor interaction and multi-level nesting. Technical attributes form the basis of rational assessment, social influence provides the external reference for decision-making, trust mechanism builds the bridge of psychological security, and risk perception and technology anxiety act as psychological brakes to constrain the acceptance behavior. This mechanism reveals the nature of technology acceptance among the elderly: it is not only an individual cognitive judgment, but also a comprehensive product of social relationship, emotional experience and psychological safety. Therefore, to promote the acceptance of VR shopping among the elderly, it is necessary to go beyond the purely technical optimization thinking, turn to the overall construction of the socio-technical system, and make concerted efforts at multiple levels of technology, system, and culture to create a friendly, inclusive, and supportive digital consumption environment for the elderly.

CONCLUSIONS AND PRACTICAL IMPLICATIONS: FROM ACADEMIC DISCOVERY TO SOCIAL ACTION

By constructing an extended UTAUT theoretical model, this study systematically explores the influencing factors and mechanisms of the willingness of elderly consumers to accept virtual reality shopping, and obtains a series of findings with theoretical value and practical significance. The study confirms that performance expectation, effort expectation and social influence have significant positive effects on the VR shopping intention of elderly consumers, while perceived risk and technology anxiety have significant negative effects. More importantly, the study reveals the key mediating role of trust between technology attributes and behavioral intention, which deepens the understanding of the psychological mechanisms of technology acceptance among older adults. Overall, the explanatory power of the extended

model on the VR shopping intention of elderly consumers reaches 71.2%, which is significantly better than that of the original UTAUT model, proving the validity of the theoretical extension for a specific population. These findings not only enrich the application of technology acceptance theory in the elderly group, but also provide a scientific basis for the promotion of VR shopping in the silver-haired market.

From the perspective of theoretical contribution, this study expands the boundaries of the existing literature in three aspects. First, by focusing on the elderly, a relatively neglected population in mainstream technology acceptance studies, this study fills the demographic gap in VR shopping acceptance studies. While most of the existing studies focus on young people or adults in general and pay little attention to the elderly as a special group, the elderly perspective of this study provides new insights for understanding the intergenerational digital divide. Second, by introducing gerontological variables such as perceived risk, trust, and technology anxiety, the explanatory power of the UTAUT theoretical framework is enriched in specific contexts. The inclusion of these variables is not a mechanical stacking of variables, but an interdisciplinary integration based on geropsychology, consumer behavior, and sociology of technology, reflecting the rigor and necessity of theoretical expansion. Third, the mediating mechanism of trust was revealed, linking the functional evaluation of technological attributes to the emotional experience of psychological safety, deepening the understanding of the black box of geriatric technology acceptance. This finding suggests that future research can further explore the interactions among affective, cognitive, and social factors in geriatric technology adoption and construct a more refined theoretical model.

In terms of practical implications, the findings of this study are valuable for multiple stakeholders. For VR technology developers and retailers, the findings emphasize the importance of age-appropriate design. First, the performance expectations of VR shopping should be raised, so that older consumers can actually feel the advantages of VR shopping in terms of saving time, providing information, and assisting in decision-making through clear product displays, convenient search functions, and personalized recommendation algorithms. Secondly, lower the expectation of efforts, simplify the operation process, optimize the interaction interface, provide voice navigation, gesture control and other multi-modal interaction methods, so as to reduce the learning burden of the elderly. Third, establish a trust mechanism, improve the system of real-name authentication, safe payment, product traceability, after-sale protection, etc., and enhance the trust of elderly consumers through authoritative third-party certification, user evaluation display, and consumer rights protection commitment. Fourth, reduce perceived risks, strengthen data privacy protection, provide clear return and exchange policies, set consumption limit reminders, open exclusive customer service hotlines for the elderly, and promptly respond to and handle the concerns and complaints of elderly consumers. Fifthly, to alleviate technological anxiety, design a novice guidance model, provide step-by-step tutorials and virtual assistants, create a relaxed atmosphere that encourages trial and error, and gradually build up the self-confidence of the elderly with successful experiences.

For governments and social organizations, the results of the study emphasize the urgency of building an age-friendly digital ecosystem. Firstly, we should strengthen the construction of digital infrastructure, push down the price and improve the performance of VR

equipment, and explore the modes of community sharing of VR equipment and public experience centers, so as to lower the threshold of older people's access to VR technology. Secondly, carry out large-scale digital literacy training, incorporate emerging applications such as VR shopping into the curriculum of universities for the elderly and community schools, adopt socialized learning methods such as bringing the elderly along and teaching children, and activate the social support network of the elderly. Third, improve laws, regulations and regulatory mechanisms to combat online fraud and false propaganda against the elderly, establish a rapid response mechanism for the protection of the rights and interests of elderly consumers, and create a safe and trustworthy digital consumption environment for the elderly. Fourth, promote standardization and product certification, issue design guidelines and evaluation standards for age-friendly VR products, encourage enterprises to develop age-friendly certified products, and form a market identification mechanism for quality products. Fifthly, cross-sectoral collaboration should be carried out to integrate the resources of industry and information technology, commerce, civil affairs, health care and other departments to form a policy synergy to promote the digital inclusion of the elderly, and make the integration of the elderly into the digital society as an important part of the strategy of active aging.

For families and communities, the results of the study highlight the critical role of social support in the adoption of technology by the elderly. Children should act as the main force of digital feedback, take the initiative to introduce and demonstrate the use of VR shopping to their parents, help them overcome the initial sense of unfamiliarity and fear, and give them patient accompaniment and encouragement in the process of technology adoption. Communities can organize VR shopping experience activities, technology sharing sessions, peer learning groups, etc. to create an atmosphere of mutual learning and progress among the elderly. Volunteer organizations and social work agencies can develop digital companion programs for the elderly, and provide one-on-one technical support and psychological care for vulnerable elderly groups such as those living alone, the elderly and low-income earners, so as to ensure that no elderly person will be left behind in the technological advancement. These grassroots, humanized social support networks are the last mile in promoting digital inclusion for the elderly, and an important channel for translating research findings into social change.

Of course, there are some limitations in this study, which point out the direction for future research. First, the sample coverage is mainly concentrated in urban areas, and is not representative of special groups such as rural elderly and ethnic minority elderly. Future research can expand the geographical and population diversity of the sample to explore a wider range of heterogeneous characteristics. Second, the cross-sectional design of this study only reveals the correlation rather than causation between variables. In the future, a longitudinal tracking or quasi-experimental design can be used to examine the dynamic evolution of the acceptance process of VR shopping among the elderly. Third, this study focuses on the willingness to accept rather than the actual use behavior. Although behavioral willingness is an important antecedent of behavior, there is still an intention-behavior gap between willingness and behavior, and future studies can incorporate the actual use data into the model to examine the transformation mechanism from willingness to behavior. Fourthly, the study is mainly based on quantitative methods, and there is not enough exploration of the deep psychological mechanisms and cultural values of the elderly. In the future, we can adopt a mixed research

method, combining in-depth interviews, ethnographies, and other qualitative means, to enrich the three-dimensional understanding of the phenomenon of the acceptance of the elderly technology.

Looking ahead, with the maturity of VR technology, popularization of equipment and rich applications, virtual reality shopping is expected to become an important channel of consumption for the elderly, but the realization of this vision requires the synergistic promotion of technology, market, society and policy. At the technical level, it is necessary to continue to optimize the wearing comfort, interaction naturalness and content adaptability of VR equipment, and develop more VR shopping applications that are suitable for the cognitive characteristics and life needs of the elderly. At the market level, it is necessary to cultivate the business ecology of elderly VR consumption, encourage enterprises to invest in the R&D and operation of the elderly market, and explore sustainable business models. At the social level, it is necessary to eliminate stereotypes and age discrimination against the elderly, recognize their ability and desire to learn new technologies, and provide them with equal opportunities for digital participation. At the policy level, it is necessary to incorporate digital inclusion of the elderly into the national strategy and provide institutional safeguards in multiple dimensions, such as legal, financial and public services. Only through the combined efforts of all parties can virtual reality shopping truly become an effective tool for the elderly to enjoy the digital dividend and improve their quality of life, instead of exacerbating another barrier to the digital divide.

From a broader perspective, the acceptance of VR shopping for the elderly reflects the fundamental challenge of the digital age: how to maintain social inclusiveness and fairness in the rapid iteration of technology? As the group with the richest life experience and the most outstanding social contribution, the elderly should enjoy the convenience brought by technological progress on an equal footing, rather than passively becoming digital refugees. Promoting the integration of the elderly into the digital society is not only a need for economic development and an opportunity for industrial innovation, but also a requirement for social justice and a manifestation of humanistic care. It requires the whole society to change its concept, from treating the elderly as the burden of technology to the partner of innovation, from one-way technological indoctrination to two-way co-design, and from emergency problem repair to systematic ecological construction. Only when we truly understand and respect the needs, abilities and dignity of the elderly can technology become a force for intergenerational connection, well-being and harmony, rather than a factor that creates barriers, exacerbates divisions and generates anxiety.

Finally, this study calls on academics, industry, policymakers and all sectors of society to work together to address the new challenges posed by the intersection of population aging and digitalization. Academics should continue to deepen the theoretical research and empirical exploration on the acceptance of technologies for the elderly, so as to provide scientific guidance for practice; the industry should take the ageing-friendly design and silver-haired market development as a strategic focus, so as to create a win-win situation in terms of social value and commercial value; the policy sector should improve the legal system and public services of digital inclusion, so as to protect the digital rights of the elderly; and the society should create a cultural atmosphere of respecting, honoring and helping the elderly, so as to

form a new intergenerational culture of respecting, honoring and helping the elderly. All sectors of society should create a cultural atmosphere of respecting, honoring and helping the elderly, and form a social trend of intergenerational integration. Let us work together to build a digital society in which no one is left behind, so that every elderly person can embrace technological progress and share a better life with dignity. This is not only the academic vision of this study, but also the moral commitment and historical responsibility of an aging society.

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