


## Article

# The Continuous Intention of Older Adult in Virtual Reality Leisure Activities: Combining Sports Commitment Model and Theory of Planned Behavior

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**Abstract:** Digital devices are being increasingly adopted for healthcare purposes. The present study investigates the continuous intention of older adults in virtual reality leisure activities by using a sports commitment model and the theory of planned behavior to develop a new planned behavior model, and by testing the model using a sample of 388 older adults following three months of firsthand experience. The results show that sports commitment has a positive influence on continuance intention, and subjective norms and perceived behavioral control are the strongest predictors of continuous intention in virtual reality leisure activities. Further, the participation of the older adults in virtual reality leisure activities requires strong support from society as well as friends and family in order to produce continued participation. Perceived behavioral control shows that when individuals have more resources and opportunities, they face fewer expected obstacles and have greater continuance intention. In addition, the present study demonstrates that attitude influences behavioral intentions.

**Keywords:** virtual reality; leisure activities; sports commitment model; theory of planned behavior

## 1. Introduction

According to the World Health Organization (WHO), the proportion of the population over the age of 60 will increase from 11% in 2006 to 22% in 2050. An aging population is now a global trend [1]. In addition, with greater age, mobility declines while body weight steadily increases; in particular, older adults with mainly sedentary lifestyles have significantly higher body weight, fat ratio, and fat weight [2]. Craig and Cameron [3] argued that in a gradually aging society, regular physical activity has benefits for both individuals and society. For individuals, physical activity can increase the blood flow, cardiac output, maximal oxygen uptake, metabolic rate, self-confidence and self-esteem, and quality of life of older adults. For society, physical activity allows the body to exercise, which prevents chronic diseases, reduces the morbidity of the older adults, and reduces the occurrence of illness, leading to lower medical expenses and social costs. Therefore, sports are an important public health issue.

Aside from a series of physiological changes and adaptations, physical activity increases self-esteem and reduces anxiety and depression, producing a positive effect on stress relief [4]. However, due to the decline in physiological functions and reduced mobility, older adults have more difficulty in participating in sports than young people do [5]. For the older adults living in cities, rising housing prices caused by overcrowding and an increased demand for land have led to substantial reductions in urban green spaces, meaning that some larger leisure and sports facilities have moved to the edges

of cities [6]. As a result, the overcrowding of leisure facilities and inconvenient locations reduce the opportunities of older adults to participate in leisure activities [7].

In recent years, digital devices have been increasingly adopted for healthcare purposes. Due to technological development, virtual reality has become another option for leisure activities. Individuals can exercise in their homes, and are no longer subject to the constraints of the outdoor environment or weather conditions, enabling them to experience the pleasures of leisure activity indoors. Saposnik et al. [8] showed that somatosensory physical activity is safe, can be used in leisure and fitness activities, and is particularly suitable for the older adults.

Curtis et al. [9] and Vanreusel et al. [10] pointed out that participation in sports and physical activity tends to significantly decline with greater age, and half of the individuals who participate in fitness activities will withdraw in a short period of time [11]. Generally speaking, the sources of individual sport behavior and ongoing participation are closely related to the strength of individual motivation. Therefore, understanding the psychological structure of participation in physical activities and individual commitment, determination, motivation and behavior is necessary to avoid interruption to physical activity and to ensure regular participation. Iwasaki and Havitz [12] also showed that commitment is key to increasing participation and loyalty behavior. In the existing literature, the sports commitment model (SCM) is a widely accepted concept. Sports commitment is a state of mind and mode of behavior, where objectives are the most important factors in decision making, meaning that achieving actual health objectives directly determines the sport behavior of an individual [13]. Sport commitment represents a psychological state reflecting an athlete's desire and resolve to continue his or her sport participation [14], and there is empirical support for the view that high levels of sport commitment accompany greater behavioral persistence [15].

Health behaviors can be predicted and explained by psychosocial theories [16]. Currently, the theory of planned behavior (TPB) is used to understand individual intention and to predict a number of health behaviors [17]. TPB is a socio-cognitive model of the attitude-behavior relationship mediated by behavioral intentions [18]. In terms of explaining the "ongoing" participation intention of users, past studies have compared use and ongoing use. TPB has strong explanatory power for both use and ongoing use [19].

The Sport Commitment Model (SCM) is a conceptual framework designed to account for persistence behavior in sport settings [20]. The SCM has already been used to determine environmental factors in the commitment to actual sports for adults [21] and university students [20,22], and TPB is a widely used framework to understand and predict behavior [23]. However, few studies to date have combined TPB and SCM. In order to understand whether the psychological factors of sports commitment affect ongoing participation intention, the present study attempts to combine TPB and SCM to explain and predict the willingness of the older adults to participate continuously in virtual reality leisure activities.

## 2. Literature Review

### 2.1. Virtual Reality Leisure Activities

Virtual reality is a computer-generated reality that allows users to enter a virtual world through a computer interface and gain experiences equivalent to those in the real world [24]. It is defined as the sum of the hardware and software systems that seek to provide the sensory illusion of being present in another environment. Virtual reality can be classified as desktop, immersion, projection, simulator or hybrid [25].

Virtual reality systems combine graphics, sound, video, and animation with related surroundings to produce human-machine communication and interaction, offering a completely new 2D and 3D visual, auditory, and interactive human-machine interface [26]. Immersion, presence and interactivity are the core characteristics of virtual reality technologies [27]. Interactivity can be described as the degree to which a user can get feedback from a virtual reality environment in real-time. Presence is

described as the subjective experience of being in one place, even when one is physically situated in another. As to immersion, it means the extent to which the computer displays are capable of delivering a surrounding and vivid illusion of reality. Recently, virtual reality technologies have been applied in various domains. In this study, we focus on immersive virtual reality applications in healthcare and health improvement.

North et al. [28] pointed out that the virtual environment simulated by virtual reality can effectively produce psychological responses and enable users to achieve the same experiences as those in the real world. Lim et al. [29] used virtual reality to simulate images of the natural landscape of a garden, finding that they can effectively stimulate reactions among the subjects viewing the landscape, so that the use of virtual reality to represent the natural environment is effective. Herrero et al. [30] used virtual reality to represent different natural environments, showing 20 min films of five different natural environments (i.e., forest, desert, grassland, snow field and beach) to patients. The results showed a significant difference in emotions, such as moodiness, pleasure, energy, calmness, surprise and sadness among patients prior to and after the videos were shown.

The somatosensory Wii game console launched by Nintendo in 2006 has achieved worldwide popularity. In particular, the Wii Sports virtual reality sports games have transcended traditional video games with the virtual reality produced by intuitive human-machine interaction and somatosensory operation; the games are both simple and fun, and provide the opportunity for players to exercise. This successful virtual reality human-machine interaction involves many leisure categories including sports, exercise, and weight loss. Wii Fit was launched in 2008, and provides 48 game types. Each game type has its own sports training purposes, including balance training, aerobics, yoga and muscle training, giving users a clear understanding of their physical condition and benefitting their health management [31]. The Wii is seen as a health-promoting tool because it can provide purposeful and meaningful activities [32]. Wii sport is simple, safe and fun, while providing players with the opportunity to exercise, making it a new option for sport, exercise and weight loss [33]. The Wii is perceived to be easy to use, providing a way for older adults to socialize with others, and giving them opportunities to participate in activities in new ways [31]. For older adults, especially those with disabilities, virtual reality leisure activities are easier to participate in as compared with real-world leisure activities [34].

In Williams' [35] study of fifteen older adults aged 76 or over in a senior community, each respondent played Wii Fit somatosensory games for twelve weeks. The study found that Wii Fit somatosensory games can improve body balance among older adults as well as enhance self-confidence. Furthermore, the level of acceptance among the older adult respondents was high. As well as improving balance, the use of Wii Sports can improve subjects' mental health, cognitive function, and symptoms of depression [35,36]. Clearly, apart from increasing the convenience of activity participation, virtual reality leisure activities also yield real health benefits for older adult respondents.

## 2.2. Sports Commitment Model

Sports commitment is a state of mind, indicating a desire and determination to participate in a specific or general physical activity [15]. The purpose of developing the SCM was to have a better understanding of the antecedents of sport commitment [37]. There are six factors that can have a direct positive or negative impact on sports commitment: whether the activity is enjoyable, alternative forms of participation, personal investment, social constraints, opportunities for participation, and social support [20,21].

In its early phase, the SCM was applied in competitive youth sport domains such as football, soccer and volleyball [20], softball and baseball [38], cricket [39] and tennis [40]. Scanlan et al. [38] were the first to apply the SCM, contributing an initial measurement that established the base model for future research. Raedeke [41] used a sports commitment model to understand burnout in swimmers, finding no relationship or a weak negative correlation between social constraints and commitment, a result at variance with the positive correlation anticipated by Scanlan et al. [38].

The SCM has also been used in the fields of fitness and sports. A study by Wilson et al. [20] on 428 participants partially supported the relationship between certain structures and commitment. Personal investment and satisfaction are the best predictors of sports commitment, while social constraints and involvement options can only predict whether people want to commit. The study also showed that commitment to sport produces a greater frequency of exercise. A high level of intrinsic motivation has a positive correlation with ongoing exercise behavior. A study by Alexandris et al. [42] in Greece found that the commitment model for participants in physical exercise and fitness is both valid and applicable. The research subjects were 210 members from three health clubs (68% female, average age 33.6 years), and results showed that enjoyment, personal investment, social constraints, and involvement opportunities are significantly associated with sports commitment, demonstrating that the SCM can be used to predict a member's commitment to a fitness program and his or her ongoing loyalty.

### 2.3. Theory of Planned Behavior

Ajzen's [43] TPB focused on the decisions and related motivations for voluntary behaviors, has been widely used for personal beliefs and evaluations in areas such as health, sports, consumption, travel and management, and is an important tool for understanding and predicting human behavior [44]. At the simplest level, TPB points out that human behavior is controlled by intentions [45]. Intentions are influenced by (1) attitude, (2) subjective norms, and (3) perceived behavioral control. These three factors influence individual behavioral intention. Attitude refers to an individual's positive or negative evaluation behavior, and is determined by beliefs toward behaviors. At the same time, subjective norms indicate that individuals are under social pressure to perform specific behaviors. Perceived behavioral control refers to the resources and opportunities required for a particular behavior, the belief that the behavior reflects past experiences, and the expected obstacles and barriers that influence the behavior. These barriers may be internal factors such as skills, abilities, knowledge and complete planning, as well as external factors such as time, opportunity, and cooperation with others. In short, TPB establishes that a positive attitude and increased social pressure produce greater willingness to incorporate planned behavior into personal behavior [16].

Armitage [46] clarified these structural explanations as follows: if participants experience greater pressure from society to engage in physical activity (subjective norms) and believe that they will be successful (perceived behavioral control), they will more actively participate (attitude) in these planned behaviors. Except attitude, subjective norms and perceived behavioral control, sports commitment is also viewed as an exercise orientation that reflects a person's attitude towards doing exercises. Therefore, sports commitment increases the commitment and the likelihood of participation in physical activities.

### 2.4. Research Hypothesis

The prerequisites of whether an individual will engage in a certain behavior do not only include whether the individual is committed to the particular behavior. More important is whether there is a plan for the activity. In the cases where there is commitment but also a lack of a sufficient plan, the result is frequently a high level of willingness on the part of the individual but no way to put it into practical action. TPB refers to an individual's way of life, and addresses how these beliefs determine behavior and action, and is frequently used in the fields of sports and physical activity to predict behavior [43]. This theory considers how much effort individuals are willing to make, in order to continue to engage in activities. This is similar to the SCM, which reflects the psychology of desire and psychological commitment to ongoing participation in specific programs or activities. TPB asserts that commitment is the most important factor determining individual behavior, while SCM assesses an individual's cognitive psychology toward sports rather than his or her actual participation. However, in TPB, intentions are the strongest predictors of behavior. Therefore, SCM can be used to expand TPB. If individuals plan participation in sports and apply commitment, they will be more keen to participate.

Therefore, the present study proposes the following hypotheses on the continuous intention and sports commitment of older adult participants in community sports activities.

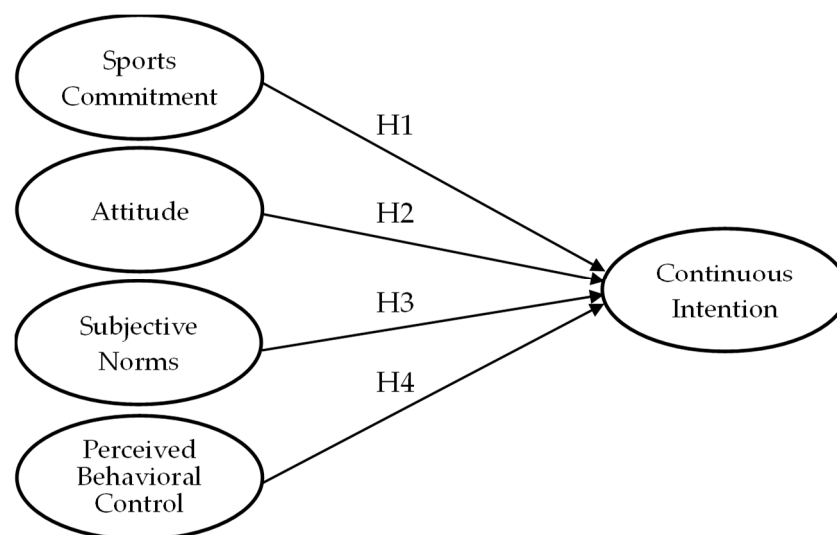
**Hypothesis 1 (H1).** *Sports Commitment has a significant positive influence on continuous intention.*

**Hypothesis 2 (H2).** *Attitude has a significant positive influence on continuous intention.*

**Hypothesis 3 (H3).** *Subjective norms have a significant positive influence on continuous intention.*

**Hypothesis 4 (H4).** *Perceived behavioral control has a significant positive influence on continuance intention.*

According to the research hypotheses produced from the above literature review, we constructed a conceptual model for the continuous intention of older adult participants in virtual reality sports, as shown in Figure 1.



**Figure 1.** Conceptual model for the continuous intention of older adult participants in virtual reality sports.

### 3. Research Methods

#### 3.1. Samples and Data Collection

Wii, a virtual reality-based video game, was utilized in the study as a virtual reality sport device. It is a home video game console released by Nintendo in 2006. Wii can improve the sense of balance and improve the effects of exercise and rehabilitation. Therefore, Wii is utilized most often as an effective tool for enhancing older or disable people's physical ability and for improving their everyday life capability [47]. Wii Sport, Wii Fit and Wii Fit Plus are all popular in leisure or healthcare research. Users use the handle to play Wii Sport video games. However, users use balance boards to play Wii Fit and Wii Fit Plus games. It is much easier for elders to learn and play Wii Sport. Therefore, we chose Wii Sport as the virtual reality game in our study.

The study adopted a structured questionnaire to collect data in two stages. First, we chose eight high-quality older adult community care centers in the Taichung region. We invited the older adults who were willing to participate in virtual reality sports. In total, we recruited 450 individuals and then provided a set of virtual reality video games and devices (Golf and Bowling of Wii Sport) for free to each community.

We dispatched personnel to the care centers during their activity times Monday to Friday to facilitate the activities, with 2–4 people playing the game at the same time, and a new group taking



over once the original group became tired. Each subject played Wii games with the handles for at least 15 min once a week for three months; in total each individual played with the Wii at least 10 times and for 150 min in stage 1.

In the second stage, after three months, personnel were sent to the communities to survey the participating older adults. Before inviting the older adults, we ensured that they could express their opinions correctly and precisely. Taking into consideration the older adult respondents' vision and ability to complete the form, research assistant read the questionnaire aloud to the respondents in one-to-one sessions. Because blind elders cannot play Wii games, no blind elders were recruited in this study. Respondents were asked to answer with strongly agree, agree, neither agree nor disagree, disagree, or strongly disagree, according to their experiences, while the interviewers recorded the answers. Since some participants withdrew during the program, only 415 participants completed the experiment. Some of the respondents became impatient during the interview process, and terminated the interview before its completion. Excluding these invalid questionnaires, there were 388 valid questionnaires, giving an actual response rate of 78%.

### 3.2. Questionnaire Design

The present study used a questionnaire survey, with the scales having, as far as possible, good reliability and validity from the literature. Operational definitions for each of the variables are produced based on the behavior definitions of the older adult participants in the virtual reality sports. The original scales in the literature in English were translated into traditional Chinese by two translators. The Chinese version scale was then translated back into an English version. We compared the original scale and the back-translated scale. We ensure the meaning of the items in the two scales was almost the same. After the back-translation check, the questionnaire was tested by 3 older adults to ensure all items were readable. After the pretest, we modified some minor wording problems and established a formal questionnaire.

The questionnaire is divided into three parts. The first part is sports commitment, which refers to the sports commitment scales developed by Wilson et al. [20], Scanlan et al. [48], and Carpenter et al. [49]. The operational definition of sports commitment is the desire and determination of older adults toward ongoing participation in virtual reality sports. A total of four items are included: I am dedicated to participating in sports in a team; it would be difficult for me to quit the sport; I am determined to keep up my participation in the sport; and I will do everything possible to keep participating in the sport.

The second part is concerned with attitude, subjective norms, perceived behavioral control, and ongoing behavior in TPB. Attitude is defined as the positive evaluation given by older adult participants of virtual reality sports. The operational definition of subjective norms is that older adult participants only participate in virtual reality sports due to social pressure. The operational definition of perceived behavioral control is access to the resources and opportunities required by older adult participants for participation in the sport. The items used are primarily revised from the work of Jess [22] and Ajzen [50], with a total of 7 items. In addition, continuous intention refers to the probability or possibility of the ongoing participation of the older adult participants. The items used were primarily revised from the work of Casper and Andrew [51], with a total of 3 items (see Table 1). The items in both the first and second parts use a Likert five-point scale to measure the degree of agreement of the respondents with each description, from strongly disagree (1) to strongly agree (5). The third part is the respondents' basic demographic information, including gender, age, frequency of participation in sports each week, years of participation in sports, and intensity of sports. After the preliminary design of the questionnaire, we sent the questionnaire and procedure to the Research Ethics Committee of National Cheng Kung University, Taiwan, for ethical review. This study was conducted under approval number No.104-154.

**Table 1.** Operational definitions of variables and source.

Variables	Items	Source
Sports Commitment (SC)	1. I am dedicated to participating in sports in a team	Jess [22]; Scanlan et al. [48]
	2. It would be difficult for me to quit the sport	
	3. I am determined to keep up my participation in the sport	
	4. I will do everything possible to keep participating in the sport	
Attitude (AT)	1. Sports are beneficial to me	Wilson et al. [20]; Ajzen [50];
	2. Sports are enjoyable to me	
	3. Participation in sports is a wise choice	
Subjective Norms (SN)	1. Family and friends think that I should participate in sports	Jess [22]; Ajzen [50]
	2. It seems that everyone in society is participating in sports, so I should also participate	
Perceived Behavioral Control (PBC)	1. If I want to participate in sports, I can do it	Ajzen [50]
	2. Participation in sports is easy for me	
Continuous Intention (CI)	1. I intend to participate regularly in community sports	Casper and Andrew [51]
	2. In the future I will continue to participate in virtual reality sports	
	3. In the future I will regularly participate in virtual reality sports	

## 4. Research Results

### 4.1. Analysis of the Sample

Of the 388 valid questionnaires, there were 134 males (34.5%) and 254 females (65.5%), with 216 respondents aged 61–65 making up the largest number (55.7%), followed by 131 respondents aged 55–60 (33.8%). A majority of respondents had a monthly income of TWD 15,001 to TWD 30,000, accounting for 54.4% of all respondents, followed by those with an income of less than TWD 15,000 (28.4%). Most respondents had a senior high school and vocational education (39.6%) or a junior high school education (27.2%). A total of 230 respondents had previously participated in sports-related community activities (59.3%), while 158 participants had no such experience (40%). A total of 160 respondents participated in sports once a week (41.2%), followed by 94 participants (28.4%) who participated twice a week, while 62 participants (16%) participated more than four times a week. The largest number of participants (137 participants, 35.5%) had participated in sports for 1–11 months, followed by those who had participated for 12–36 months (28.4%).

### 4.2. Reliability

Reliability is an important criterion for evaluating research tools. In terms of the reliability analysis of latent variables, the Cronbach's  $\alpha$  reliability coefficients for attitude, subjective norms, perceived behavioral control, sports commitment and continuous intention are 0.84, 0.80, 0.63, 0.73

and 0.84, respectively. These numbers satisfy the minimum acceptable level of 0.5 suggested by Hair et al. [52], showing that the scale has good internal stability and consistency (see Table 2).

**Table 2.** Reliability of variables.

Variable	Mean	S.D.	Cronbach's $\alpha$
SC	CO1	3.77	0.88
	CO2	3.92	0.73
	CO3	3.85	0.76
	CO4	4.11	0.70
AT	AT1	4.05	0.66
	AT2	4.04	0.68
	AT3	4.11	0.65
SN	SN1	3.81	0.72
	SN2	3.83	0.73
PBC	PBC1	3.82	0.68
	PBC2	3.73	0.67
CI	IN1	3.63	0.69
	IN2	3.74	0.68
	IN3	3.73	0.68

#### 4.3. Correlation Analysis

Bagozzi and Yi [53] suggested that the sample size should be based on the model fit, measured as the ratio of the chi-square value ( $\chi^2$ ) to its degree of freedom. However, the chi-square value is very sensitive to the size of the sample being tested. With a larger sample size, it is easier for the chi-square value to reach significance, increasing the possibility of the theoretical model being rejected. Therefore, the normed chi-square (normed  $\chi^2$ ) ( $\chi^2/\text{df}$ ) has been suggested as a better measure of the goodness of fit ratio. In order to test the model fit ratio, the present study used the chi-square degree of freedom ratio ( $\chi^2/\text{df}$ ). A ratio of less than 3 is an acceptable model fit ratio. The overall goodness of fit indices were  $\chi^2/\text{df} = 2.28$ , Goodness of Fit index (GFI) = 0.93, Adjusted Goodness of Fit Index (AGFI) = 0.90, Comparative Fit Index (CFI) = 0.97, Root Mean Square Residual (RMR) = 0.01 and Parsimonious Goodness of Fit Index (PGFI) = 0.76 (see Table 2). These results showed that all of the variables meet the criteria for validating research hypotheses.

The latent variables include attitude, subjective norms, perceived behavioral control, sports commitment and ongoing participation. Pearson's correlation analysis showed that the correlation coefficients between the attitude, subjective norms, perceived behavioral control, sports commitment and ongoing participation behavioral variables are 0.35 ( $p < 0.001$ ), 0.45 ( $p < 0.001$ ), 0.38 ( $p < 0.001$ ) and 0.27 ( $p < 0.001$ ), reaching the 0.5 significance level. The correlation coefficient for attitude and subjective norms is 0.52 ( $p < 0.001$ ). The correlation coefficient for perceived behavioral control and attitude is 0.32 ( $p < 0.001$ ). The correlation coefficient for perceived behavioral control and subjective norms is 0.42 ( $p < 0.001$ ). The correlation coefficient for sports commitment and attitude is 0.52 ( $p < 0.001$ ). The correlation coefficient for sports commitment and subjective norms is 0.33 ( $p < 0.001$ ). The correlation coefficient for sports commitment and perceived behavioral control is 0.23 ( $p < 0.001$ ). There is a significant positive relationship between each of the dimensions, with a moderate to low level of association (see Table 3).



**Table 3.** Correlation analysis between the different variables.

Variable	AT	SN	PBC	SC	CI
AT	1				
SN	0.52 ***	1			
PBC	0.35 ***	0.42 ***	1		
SC	0.34 ***	0.33 ***	0.23 ***	1	
CI	0.35 ***	0.45 ***	0.38 ***	0.27 ***	1

\*\*\*:  $p < 0.001$ .

#### 4.4. Regression Analysis

In the multiple regression analysis, as shown in Table 4, we can find that the overall F-value for the model is 35.020, and that the p-value is smaller than 0.5, showing that the overall explained variance of the regression model is statistically significant. The regression coefficients of the four predictors in the standardized regression equation (attitude, subjective norms, perceived behavioral control, and sports commitment) are all positive, showing a positive influence on continuance intention, with subjective norms and perceived behavioral control having a greater influence on continuance intention. The significance t-test values of the regression coefficients for the four independent variables are 2.009 ( $p < 0.05$ ), 5.092 ( $p < 0.05$ ), 4.255 ( $p < 0.05$ ) and 2.067 ( $p < 0.05$ ), and the variance inflation factors (VIF) are 0.201, 0.206, 0.345 and 0.313, which are all smaller than 10, and therefore there is no multicollinearity among independent variables.

**Table 4.** Regression analysis result on continuance intention.

Independent Variables	Std. $\beta$	t-Value	VIF
AT	0.106	2.009 *	0.201
SN	0.276	5.092 ***	0.216
PBC	0.208	4.255 ***	0.345
SC	0.098	2.067 *	0.313
$R^2$	0.268		
F-Value	35.020 ***		

\*:  $p < 0.05$ ; \*\*\*:  $p < 0.001$ .

#### 4.5. Testing the Research Hypotheses

Multiple regression analysis was performed to establish the relationships between the variables and test the research hypotheses. The results are shown in Table 5. The four hypotheses are supported, with  $p$  values reaching the significance level of 0.05.

**Table 5.** Hypothesis testing results.

Path	$\beta$	t-Value	Results
H1: Sports Commitment $\rightarrow$ Continuous Intention	0.098	2.07 *	Supported
H2: Attitude $\rightarrow$ Continuous Intention	0.106	2.01 *	Supported
H3: Subjective Norms $\rightarrow$ Continuous Intention	0.276	5.09 ***	Supported
H4: Perceived Behavioral Control $\rightarrow$ Continuous Intention	0.208	4.26 ***	Supported

\*:  $p < 0.05$ ; \*\*\*:  $p < 0.001$ .

Testing result of Hypothesis 1. The path coefficient for sports commitment and continuous intention is 0.098, with a  $t$ -value of 2.07 ( $p < 0.05$ ). Therefore, H1 is established: the higher the level of sports commitment, the greater the continuance intention. This result is consistent with findings in the previous literature (Jess [22]).

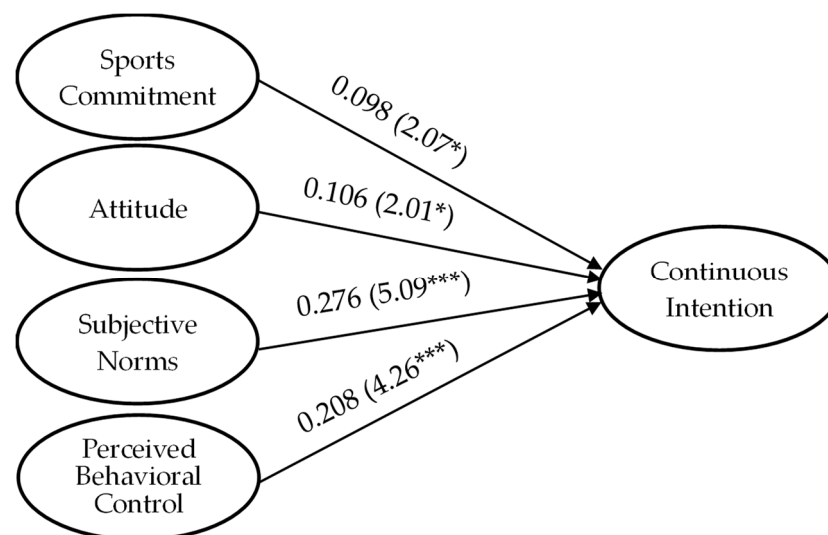
Testing result of Hypothesis 2. The path coefficient for attitude and continuous intention is 0.106, with a  $t$ -value of 2.01 ( $p < 0.05$ ). Therefore, H2 is established: the attitude of the participants in virtual

reality sports will affect their continuance intention. This result is consistent with the findings of Hsu and Lu [54] on why people continue participation in games. They found that attitude and social norms are the main factors of influence.

Testing result of Hypothesis 3. The path coefficient for subjective norms and continuous intention is 0.276, with a  $t$ -value of 5.09 ( $p < 0.001$ ). Therefore, H3 is established: higher subjective norms are associated with greater continuance intention. This result is consistent with findings in the previous literature (Karahanna et al. [19]).

Testing result of Hypothesis 4. The path coefficient for perceived behavioral control and continuous intention is 0.208, with a  $t$ -value of 4.26 ( $p < 0.001$ ). Therefore, H4 is established: higher perceived behavioral control is associated with greater continuance intention. This result is consistent with findings in the previous literature (Mummary and Wankel [55]).

In short, sports commitment, attitude, subjective norms, and perceived behavioral control all influence the intention of older adults to continue participation in sports. On this basis, we constructed a model for the continuous intention of older adult participants in virtual reality sports (see Figure 2).



**Figure 2.** Model verification results for the continuous intention of older adult participants in virtual reality sports.

## 5. Discussion and Conclusions

The present study investigated the continuous intention of older adult participants in virtual reality sports by applying sports commitment to extend TPB. Using this method, the present study predicted the motivation for and ongoing pursuit of personal goals among older adult participants in sports, producing three major empirical results.

First, the results of the study showed that sports commitment can predict continuance intention. The results demonstrated that high sports commitment and low sports commitment have the same significant effect as TPB variables. Armitage [46] found that TPB variables have a significant effect on motivation and intention toward regular physical activity in a large number of studies, even when the attendance rate is low. However, Armitage [46] did not address continued sports commitment and TPB. For older adult participants, continued participation is important. Sports commitment includes continued motivational factors, which can be directly used to measure an individual's psychological condition [38], and provide future motivational factors for individuals. For example, competitive supports may be more likely to reflect individual intrinsic motivation, such as feelings of enjoyment or challenge. However, fitness activities may be more likely to reflect extrinsic motivation, such as benefits in terms of appearance, weight, and stress management [56]. The motivations of older

adults' participants in virtual reality sports are not the same; for example, satisfying their feelings, passion, and enjoyment of sports are important motivations for continued participation [51].

Second, the present study found that attitude, subjective norms, and perceived behavioral control all influence behavioral norms, verifying Ajzen's [50] TPB. Of these, subjective norms are the strongest predictors of continuous intention for older adult participants in virtual reality sports, showing that the intention to continue participation in sports is influenced by one's peers. According to TPB, subjective norms can predict normative beliefs, reflecting whether an individual's behavior is influenced by certain influential groups. The most crucial outcome is whether there is participation behavior. Because people are social animals, when making decisions, aside from their own feelings, they are also influenced by the people around them. The main reason is that people hope that their own decisions are affirmed by others, or that they do not want their decisions to be at odds with others', thereby influencing their relationships. Older adult participants in virtual reality sports also require the support of family and friends to motivate their continued participation.

Third, perceived behavioral control has a stronger effect on continuous intention for participants in virtual reality sports than sports commitment or attitude. In addition, the perceived behavioral control comes from direct experiences or actual contact with knowledge and information. This special attitude structure can change existing beliefs [42]. Older adults tend to become rigid in their thinking, and retired people are not able to obtain information about technology as quickly as younger people can. Therefore, it is necessary to provide friendly advice services. This is because when individuals have more access to resources and opportunities, they will face fewer expected obstacles. Greater evaluations of perceived behavioral control are associated with greater continuance intention.

Aside from its theoretical contributions, the present study can assist, in practical terms, relevant organizations, such as older adults' welfare institutions and nursing homes, when planning leisure activities for the older adults, or firms when developing software marketing strategies. In short, sports commitment, attitude, subjective norms, and perceived behavioral control are important factors determining continued participation, and objectives are the most important factor in individual behavior. In other words, actual health objectives directly determine an individual's sports behavior. As long as older adults are given help in realizing that the Wii has health benefits, this can generate ongoing participation intention. The present study showed that subjective norms and perceived behavioral control are stronger predictors of continuance intention. It also determined whether older adult participants in Wii virtual reality leisure activities are supported by society as well as by family and friends, and what resources and opportunities are required for the older adults to participate in these activities. These findings can serve as a reference to software companies when they develop marketing for their software. Aside from emphasizing the health benefits of products, they can also highlight the benefits to relations with family and friends through the enjoyment of the same activity, as well as the advantages of a simple operation.

In addition, although activity theory points out that older adult participants can achieve greater leisure benefits when they participate in more types of leisure activities, if the activity is one that an older adult has not previously participated in (such as the Wii or high-tech virtual reality leisure activities), and these exceed the capacity of the older adult participants, increasing stress, then there will be no leisure benefits or health benefits. As a result, in order to increase the willingness of older adults to participate in virtual reality leisure activities using the Wii, firms or other organizations can enable older adults to actually try out the activities, thereby accumulating experience and reducing unfavorable attitudes toward technological products. When helping older adults engage in their initial contact with this activity, in order to develop interest toward the activity, it is necessary to organize classes to teach the activity. Related organizations can make use of aging learning centers, colleges for the older adults, and older adults' community care centers to arrange courses on Wii virtual reality leisure activities, using an immersive design concept to promote community participation. In addition, setting up Wii stations in nursing homes and helping to develop exercise habits among residents will

provide a new opportunity and direction for health promotion of the older adults, which in turn will help address the problem of ever-increasing medical costs in an ageing society.

This research only takes Wii users from Taiwan's senior age group as the research object. Therefore, the generalizable effect for other communities or areas must be further studied. Secondly, in the proposed research model, we only include sports commitment, attitude, subjective norms and perceptual behavior control. Future research can consider more factors and further explore the relationship between actual practical behavior and health outcomes. Finally, the data in this study is cross-sectional. We suggest future studies collect longitudinal data to explore virtual reality device-usage patterns for older adults.

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