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2015

Wu, Z., Li, J., & Theng, Y.-L. (2015). Examining the Influencing Factors of Exercise Intention Among Older Adults: A Controlled Study Between Exergame and Traditional Exercise. *Cyberpsychology, Behavior, and Social Networking*, 18(9), 521-527.

<https://hdl.handle.net/10356/80856>

<https://doi.org/10.1089/cyber.2015.0065>

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**Accepted Manuscript in Cyberpsychology, Behavior, and
Social Networking**

Published in 17 (8), 519-527

The final publication is available at

<http://online.liebertpub.com/doi/abs/10.1089/cyber.2015.0065>

Examining the Influencing Factors of Exercise Intention among Older Adults: A
Controlled Study between Exergame and Traditional Exercise

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Acknowledgments

The authors would like to thank the staff and participants in Caregiving Welfare Association, Care Corner Seniors Activity Center, Cheng San Communities Club, and Toa Payoh East Silver Center. This project was supported by The Tsao Family Fund. The Institutional Review Board ethics approval number for experiment conduction is 200604393R.

Abstract

Objective: Promoting physical activities among older adults becomes an important component of successful aging. The aim of this study was to assess the influence of both exercise settings and player interaction patterns on exercise intention in a sample of Asian older adults.

Method: A 2 (exercise settings: traditional exercise vs. exergame) $\times$ 2 player interaction patterns: (collaborative vs. competitive play) between-subject experimental intervention was conducted with 113 Singaporean older adults for one month. Interviewer-administered questionnaire survey was issued to measure key variables of enjoyment, social presence and perceived behavioral control.

Results: The findings supported the importance of social presence and perceived behavioral control in older adults exercise prediction, and highlighted the effect of collaborative play in older adults exercise promotion. Compared to traditional exercise, the effect of exergame on motivating older adults exercise was significantly lower.

Conclusion: The findings of this study revealed rich directions for future elderly exercise research, and provided strategies that could be applicable for policy making and game design to promote elderly exercise participation.

Keywords: exergame; traditional exercise; player interaction; exercise intention; older adults.

Examining the Influencing Factors of Exercise Intention among Older Adults: A Controlled Study between Exergame and Traditional Exercise

1. Introduction

In recent decades, successful aging has been the focus of public health because of the increasing number of older adults in the population¹. Among the various components of health, exercise is the most important one that leads to successful aging. Strong and consistent evidence has shown that participation in regular physical activities enhances health and life quality in old age²⁻⁴. Despite its potential health benefits, exercise participation has been reported to be low among older adults⁵. A majority of older people are reported to be sedentary and reluctant to exercise⁶.

Enjoyment has been found to be closely associated with exercise intention^{7,8}. Dergance et al.⁶ further indicated that lack of interest and enjoyment are prominent barriers to exercise participation among older adults. Social interaction is another important influencing factor identified by previous studies. The need for social interaction has been shown in survey studies as an important exercise motivator for elderly exercise^{8,9}. In addition to enjoyment and social interaction, perceived behavioral control was also highlighted in research on exercise for the elderly. The role of perceived behavioral control becomes significant in affecting the exercise intention of older adults because they experience a decline in their physical abilities¹⁰.

Nowadays, exergames have become a popular exercise platform for the general population¹¹⁻¹³. Recent evidence shows that exergames have the potential to promote, motivate,

and encourage physical activity^{14, 15}. Although elderly exercise has been studied for long time, few studies have been conducted to investigate the relationships between exercise intention and its influencing factors in the exergame setting¹⁶. To address this research gap, the current study aimed to examine the effects of enjoyment, social presence, and perceived behavioral control on the exercise intention of older adults in the exergaming context.

2. Literature Review

2.1 Settings Effect: Exergame versus Traditional Exercise

Compared with traditional exercise settings, exergames have several advantages, including high immersion, instant feedback, and ease of control¹⁷. These features in the exergame environment have recently drawn the attention of researchers to the elderly exercise domain. The findings of Hsu et al.¹² indicated that enjoyment in Wii bowling was significantly greater than that in a standard exercise regimen. Similar conclusions were reported in other recent studies, demonstrating that exergames could create positive feelings among older adults and even alleviate their depression^{11, 13}. Evidence shows that exergames have the potential to increase the enjoyment of older adults during exercise.

Currently, a few studies in gerontology have examined the influence of exergames on the exercise intention of older adults¹⁸. Some researchers pointed out that the design of exergames was not considerate of older players, which may negatively affect their perceived behavioral control^{19, 20}. Schieber²¹ argued that older adults also have sensory and cognitive barriers to interactive devices, such as learning difficulties, visual impairments, and manual dexterity problems. Although exergames could be an enjoyable way to increase exercise levels among older adults, further research is needed to investigate the effects of exergames on perceived

behavior control and on exercise intention as a whole because of these barriers. Consequently, the first objective of the study is to examine whether exergame, compared with traditional exercise settings, would have a different influence on the exercise intention of older adults.

2.2 Interaction Patterns Effect: Competitive versus Collaborative Play

Previous studies have highlighted that social interaction plays a crucial role in affecting exercise intention^{8,9}. According to a study by Kolt et al.⁸ investigating the reasons why older Australians engage in exercise, older adults ranked social motivation as the primary reason for exercise engagement. The study of Kirkby et al.²² also supported the significance of social interaction and indicated that social interaction deserves substantial attention in the exercise promotion of older adults. Understanding the measure and stimulation of social interaction in exergames is important because the study focuses on exergames.

By reviewing the related literature, de Kort and Ijsselstein²³ argued that the notion of “social presence” could be used to reflect social interaction levels in a gaming environment. Using social presence theory, Biocca, Harms, and Burgoon²⁴ defined social presence as the sense of connecting or being with others in a media-mediated environment. Three important dimensions of social presence were identified in this theory: 1) co-presence, which refers to the mutual sensory awareness of other participants; 2) psychological involvement, which refers to the emotional and mental connectedness between participants; and 3) behavioral involvement, which refers to the interdependence between the actions of the participants. Consequently, the concept of social presence is more precise and comprehensive in illustrating social interaction levels in exergame settings. In empirical practice, the theory has been used to measure social interaction in studies that pertain to exergames as well as to older adults^{25,26}.

Several studies have associated player interaction patterns with social interaction level ¹¹, ²³. Player interaction patterns refer to the structures of interaction between players and game objects ²⁷. Based on the literature on social play behavior and gameplay, two basic player interaction patterns were identified: competitive play and collaborative play. The findings of de Kort and Ijsselstein ²³ highlighted that collaborative play pattern has a significantly higher social presence than competitive play pattern. Hypothetically, the shared object in collaborative play motivates and promotes the communication and interaction among co-players. Instead, a personal object in competitive play may reduce the sense of empathy, which is a key psychological involvement in social presence. In addition, the fear of failure elicited by competitive play may also prevent the social connection between players. Assuming that collaborative play may cause higher intention in exergame performance is reasonable because greater interaction and the presence of others lead to increased motivation and intention in game-playing. However, studies on player interaction patterns in elderly exercise research are lacking; thus, comparing the competitive and collaborative play patterns to explore the effects of player interaction patterns on the exercise intention of older adults and its influencing factors is worthwhile in our study.

2.3 Current Study

In summary, the current study aims to examine the influence of exercise settings and player interaction patterns on the exercise intention of older adults and its influencing factors through a controlled comparison between exergames and traditional exercise. Specially, for the influencing factors, we focused on enjoyment, social presence, and perceived behavioral control. In this study, exercise intention is further subdivided into two types: 1) general intention, which is the intention to exercise regularly; and 2) group intention, which is the intention to attend

group exercise programs regularly. The exploration of group exercise intention also becomes significant and valuable for both academic and nursing domains because older adults face problems of loneliness and social isolation ²⁸.

3. Method

The study employed a four-week 2 (exercise settings: exergame versus traditional exercise) by 2 (player interaction patterns: collaborative versus competitive play) between-subject factorial design.

3.1 Participants and Stimulus

Participants were recruited from several senior activity centers and community clubs in Singapore. Both the elderly population (aged 65 years and above) and the pre-elderly population (aged 55 to 64 years) were considered for the study. The participants were included if they were healthy enough to exercise. However, those with severe cognitive or psychiatric conditions were excluded to avoid accidents. A total of 113 older adults who fulfilled the inclusion criteria voluntarily participated in this study.

XBOX Kinect was used as the exergame platform in the study. The console provides a pure gesture controller, which is preferred by older adults ²⁹. The game selected was “Kinect Sport Bowling” ³⁰, because bowling is a short, popular, and easy-to-learn mini-game for older adults. Accordingly, we applied an indoor bowling set as the traditional exercise setting for comparison. Similar bowling play rules and score rules were applied for both settings.

Collaborative play and competitive play rules were designed on the basis of previous studies ³¹. In the collaborative play pattern, the participants were divided into two teams for team

competition. Those in the same team were required to play bowling by turn. After 10 turns (i.e., five people in a team played two times), the team with a higher total score won. The student assistant announced the winning team and encouraged the losing team to do better in the next round. In the competitive play pattern, instant competition between pairs of participants was conducted, and the winner could continue competing with the next participant. No team was formed in the competitive pattern, and participants played with their personal goal.

3.2 Measurements

Enjoyment. The Physical Activity Enjoyment Scale (PACES) is widely used for testing exercise enjoyment³². The original scale consists of 18 items, which were tedious to answer for the older adults. Thus, a modified five-item PACES developed by Graves et al.¹¹ was adopted in the current study. Each item consists of a 5-point Likert scale, from 1 (“not at all”) to 5 (“very”), to assess the way participants feel about exercise (for example, “exercise is fun”).

Social presence. The Social Presence in Gaming Questionnaire³³ was adopted in the current study. Given the game design rules in the two interaction patterns, items reflecting positive feelings of togetherness were selected to measure social presence during the exercise interventions. A total of seven items (e.g., during exercise, you empathized with the others) used a 5-point Likert scale ranging from never to very often.

Perceived behavioral control. Perceived behavioral control was measured using a three-item instrument suggested by Rhodes and Courneya³⁴. Each item consists of a 5-point Likert scale to evaluate the perceived control of participants to exercise, such as “how confident are you that you will be able to exercise at least two to three times a week in the next 3 months.”

Exercise intention. The general exercise intention was assessed by three 5-point scales adopted from Ajzen³⁵; a sample item includes, “do you intend to exercise two to three times a week in the next 3 months.” A separate measure for group exercise intention was issued by adding the statement “Given the opportunity to attend a group exercise program in the future” before the 3-item general intention questions.

3.3 Procedure

After being approved by the Institutional Review Board, this intervention was conducted from May to June 2012 at three senior activity centers and one community club. After finishing the consent form and pre-survey, the participants were assigned to one of the four experimental conditions: 1) traditional exercise and collaborative play, 2) traditional exercise and competitive play, 3) exergame and collaborative play, and 4) exergame and competitive play. The interventions were implemented at the centers or the club where the participants were recruited. The total experimental period lasted for four weeks, with two sessions every week. In each session, the participants from the four conditions spent the same amount of time playing bowling, which was approximately one hour. The participants were encouraged to attend every session, although they could withdraw at any time. After all the sessions, an interviewer-administrated post-test survey was conducted to collect the self-reported data from participants on their exercise intention and its influencing factors.

3.4 Statistics

All data were entered into IBM SPSS 20 for descriptive analysis. To comprehensively examine the relationships between the variables mentioned, we adopted structural equation modeling (SEM) for data analysis. A casual model was formulated based on the previous

literature: exercise intention among older adults would be influenced by enjoyment, social presence, and perceived behavioral control, whereas exercise settings and player interaction patterns would affect these factors as well as exercise intention. In addition, enjoyment would be affected by social presence and perceived behavioral control^{36, 37}. AMOS 19 was used for the SEM test. Bootstrap method was applied to deal with the multivariate normality issue.

4. Results

Ten out of 113 participants dropped out during the intervention period. From the 103 completed responses in the post-test survey, eight cases were identified as outliers based on the Mahalanobis distance in AMOS and were excluded from the final analyses. Consequently, only 95 cases were left in the final sample. Table 1 illustrates the descriptions of the participants and variables in the four conditions.

Confirmatory factor analysis (CFA) was performed first to test the measurement models for both general and group intentions. After factor loadings of observed items on latent variables, two items from social presence were removed for their low factor loading values³⁸. Next, the construct reliability and validity were examined. Table 2 shows the construct reliability and validity scores. Based on the assessment criteria, no construct reliability and validity issue was reported in these two models. After performing CFA, we used the maximum likelihood method to assess the structural models. The model fits of structural models were tested and are shown in Table 3. Based on the literature, the model fits in both models were considered acceptable³⁹. Thereafter, the estimations of path coefficient values on the proposed models were calculated. The results of the analysis for both the general and group intentions are depicted in Figures 1 and 2, respectively.

In general, the participants had positive responses on exercise. For the setting effect, older adults in the traditional exercise setting were reported to have a significant higher group exercise intention ($M_{\text{traditional exercise}} = 4.61$) than those in the exergame setting ($M_{\text{exergame}} = 4.29$) ($\beta = -0.170, p < 0.1$). The influence of exercise settings on social presence was also similar ($M_{\text{exergame}} = 4.03, M_{\text{traditional exercise}} = 4.35$) and significant in both the general intention model ($\beta = -0.196, p < 0.1$) and the group intention model ($\beta = -0.195, p < 0.1$).

For the player interaction patterns effect, compared to competitive play, collaborative play had a significantly greater effect on both general intention ($M = 4.69$ for collaborative play and $M = 4.68$ for competitive play, $\beta = -0.139, p < 0.1$) and group intention ($M = 4.52$ for collaborative play and $M = 4.43$ for competitive play, $\beta = -0.168, p < 0.1$). However, the influence of player interaction patterns on perceived behavioral control was reverse, that is, perceived behavioral control in competitive play ($M = 4.67$) was significantly higher than that in collaborative play ($M = 4.45$) in both the general intention model ($\beta = 0.211, p < 0.1$) and the group intention model ($\beta = 0.220, p < 0.05$).

Among the three proposed influencing factors, enjoyment was indicated to have no significant influence on either general or group exercise intention. Social presence showed a significant and positive relationship with general exercise intention ($\beta = 0.160, p < 0.1$). Perceived behavioral control significantly influenced both general ($\beta = 0.771, p < 0.001$) and group exercise intention ($\beta = 0.242, p < 0.05$) as well as enjoyment in both models ($\beta = 0.358, p < 0.05$ in the general intention model, and $\beta = 0.355, p < 0.05$ in the group intention model).

We dropped enjoyment and its associated paths from the original models for further analysis because most of the paths related to this variable were insignificant according to Kline⁴⁰.

The results showed an increase of the model fits in both the revised general and group intention models. Moreover, by conducting mediation analysis through bootstrap in AMOS in all of the four models (both original and revised), we found that perceived behavioral control partially mediated player interaction patterns on general intention in the revised general intention model, whereas social presence partially mediated exercise settings on general intention.

5. Discussion

5.1 Effects of Influencing Factors

This study examined the influence of different exercise settings and player interaction patterns on the enjoyment, social presence, perceived behavioral control, and exercise intention of older adults. The SEM results showed that social presence had a significant and positive relationship with general exercise intentions. This finding supports the concept stating that socializing is the primary reason for exercise engagement among older people⁸. The importance of social presence in exergame design for the elderly was also proposed by other researchers¹⁶. The mediation analysis in the revised general intention model (without enjoyment) further indicated that social presence was also a significantly partial mediator between exercise settings and general intention. The statistical results not only highlighted the importance of social presence in promoting exercise among older adults, but they also provided a new theoretical perspective in understanding motivating factors in exercise research. Perceived behavioral control was also supported to be a very important predictor of exercise intention among older adults. This finding was consistent with the results of the study by Gretebeck et al.¹⁰. The current study further determined that perceived behavioral control has a higher effect on general exercise intention than on group exercise intention. Further research is needed to explore the

possible explanation and to understand the effect of perceived behavioral control in different exercise contexts because no previous study had been conducted on this specific issue. In contrast to previous findings^{6, 41}, results from the current study did not support enjoyment to be an important influencing factor for exercise intention, with most of the enjoyment paths failing to be significant in SEM. Cultural difference is a possible explanation. In the pre-survey on these Singaporean elderly participants, 92.6% (88/95) agreed that they were responsible for keeping themselves healthy by exercising, and 98.9% (94/95) thought that people their age should engage in exercise two or three times a week. In this case, the group of older adults in Singapore might consider exercise as a duty to stay healthy rather than an enjoyable activity to engage in. The conclusions of most of the previous studies may not reflect the situation among older Asian adults because most of these studies emphasizing enjoyment in exercise intention were conducted among non-Asian populations^{6, 22, 42}. Further investigation of cultural influence is essential in the research on elderly exercise.

5.2 Effects of Settings and Play Interaction Patterns

Contrary to expectation, although exergames were believed to benefit older adults both psychologically and physically^{13, 43}, the setting effects in the study showed that a traditional exercise setting aroused more positive exercise feelings than the exergame setting. This trend was shown not only in significant relationships with social presence and group exercise intention but also in other insignificant casual relationships pertaining to exercise settings. This observation is consistent with the findings of Graves et al.¹¹, who found that older adults had greater enjoyment in using the brisk treadmill than in playing Wii Fit games. Declining age-related functions and inadequate past experience with interactive technologies are possible reasons why older adults feel less motivated to use digital platforms. On the one hand, older

adults generally suffer from a decline in sensory-perceptual processes, motor abilities, response speed, and cognitive processes^{44, 45}. These dysfunctions are likely to affect their efficiency and enjoyment in using exergames. The previous literature in fact reported that many older adults felt frustrated with their use of health technologies^{46, 47}. On the other hand, as Wollersheim et al.⁴⁸ suggested, older people make mistakes during exergame playing and then feel embarrassed and would self-criticize because of their unfamiliarity with interactive technologies. The four-week intervention period in the current study might not be long enough to compensate for the inadequate experience of the elderly with exergames. Therefore, traditional exercises might be more suitable as primary intervention for older adults without interactive technology experience. Most exergames in the current market do not have customized elements for older adults because these games were designed initially for the young generation. Given the potential physical and psychological benefits of exergames on older adults^{13, 43}, a practical implication is provided for future exergame design to consider the special requirements and preferences of older adults and to minimize their problems and negative feelings toward exergames.

Player interaction patterns were introduced in the study to arouse different levels of social interaction yet failed to be significant in predicting social presence. The design of collaborative play rules in the study should account for this failure as it lacks mutually behavioral interaction because the literature indicated that social interaction includes three parts: co-presence, psychological involvement, and behavioral engagement³⁴. The findings also demonstrated that although older adults felt less perceived behavioral control in collaborative play pattern, they had higher general and group exercise intention than those in the competitive play pattern. This finding revealed that the sense of being with others was more important than perceived competence in motivating older adults to exercise.

The study has several contributions to exercise promotion and game design pertaining to the elderly population of Asia. It has shown that collaborative play patterns should be encouraged to promote elderly exercise intentions. In addition, traditional exercise might be more suitable as the main intervention setting for the current elderly population of Singapore. In the game design domain, future exergames for the elderly should add “elderly familiar” elements to minimize their inexperience with interactive technologies. Furthermore, the design of exercise and exergames for the elderly should integrate more social interaction during the exercise process at both the cognitive and behavioral levels and should pay attention to balancing exercise difficulty in view of perceived behavioral control.

4.3 Limitations

Some limitations of this study are worth mentioning. First, we only treated social presence as a whole in understanding its effect on exercise intention. Including different dimensions of social presence in future studies, such as internal social presence and external social influence, would be more comprehensive to investigate social aspects in exercise participation among older adults. Second, although this study established an unbiased comparison between exergame and traditional exercise by applying the same bowling exercise, different games and sports could possibly lead to different results ¹². Lastly, the design of the questionnaire may cause problems in the model prediction. Five-point Likert scales may not provide enough choices for older adults; therefore, conclusions drawn from them need to be interpreted with caution.

Author Disclosure Statement

No competing financial interests exist.

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Table 1

Description of Participants and variables in Four Conditions

	Traditional exercise N = 45		Exergame N = 50	
	Collaborative N = 25	Competitive N = 20	Collaborative N = 26	Competitive N = 24
Age	65.1 (5.0) ^a	68.9 (7.4)	72.0 (6.9)	75.1 (7.5)
Gender, N (%) ^b	24 (96.0%)	13 (65.0%)	16 (61.5%)	21 (87.5%)
PBC	4.63 (0.35)	4.63 (0.55)	4.28 (0.75)	4.71 (0.51)
EN	4.87 (0.30)	4.87 (0.33)	4.75 (0.40)	4.87 (0.27)
SP	4.45 (0.52)	4.22 (0.55)	4.03 (0.68)	4.02 (0.50)
GE-I	4.87 (0.27)	4.73 (0.41)	4.51 (0.47)	4.64 (0.91)
GR-I	4.63 (0.62)	4.58 (0.72)	4.42 (0.62)	4.14 (1.17)

Note. N, number of participants; EN, enjoyment; GE-I, general exercise intention; GR-I, group exercise intention; PBC, perceived behavioral control; SP, social presence. ^aData were presented in the format of Mean (Standard Deviation). ^bData presented are female participants.

Table 2

Construct Reliability and Validity of the General and Group Exercise Intention Measurement Models

General Exercise Intention Measurement Model					
Constructs	CR	AVE	SIC		
			PBC	EN	SP
PBC	.832	.627	-		
EN	.882	.602	.151	-	
SP	.821	.505	.042	.036	-
GE-I	.916	.785	.591	.095	.100

Group Exercise Intention Measurement Model					
Constructs	CR	AVE	SIC		
			PBC	EN	SP
PBC	.833	.629	-		
EN	.881	.601	.149	-	
SP	.822	.506	.045	.036	-
GR-I	.968	.910	.058	.018	.006

Note. AVE, average variance extracted; CR, composite reliability; EN, enjoyment; GE-I, general exercise intention; GR-I, group exercise intention; PBC, perceived behavioral control; SP, social presence; SIC, squared inter-construct correlation.

Table 3

Model Fit of the Structural Models

Model fit indices	General intention	Group intention	Recommended guidelines
χ^2	150.593 df = 120 p = 0.031	171.747 df = 120 p = 0.001	
χ^2/df	1.255	1.431	< 3
RMSEA	.052	.068	< .07
PCLOSE	.433	.108	> .05
TLI	.959	.938	> .90
CFI	.968	.951	> .90
PGFI	.603	.596	> .50
SRMR	.0775	.0811	< .09

Figure 1. Regression weights for the general exercise intention model

Note. $*p < 0.1$; $**p < 0.05$; $***p < 0.001$;

$\longrightarrow$ significant path; $---\longrightarrow$ insignificant path.

Figure 2. Regression weights for the group exercise intention model

Note. $*p < 0.1$; $**p < 0.05$; $***p < 0.001$;

$\longrightarrow$ significant path; $---\longrightarrow$ insignificant path.