

Fox Hunting Game: User evaluation of an exergame for community-dwelling older adults to support their mobility

Ate Dijkstra PhD MEd^{a,*}

Hetty Kazimier-van der Zwaag MSc^a

Wiebe Kooistra BA^a

Guido Swildens MSc^b

^aResearch Group iHuman, NHL University of Applied Sciences, Leeuwarden, the Netherlands;

^bCommunication & Multimedia Design, NHL University of Applied Sciences, Leeuwarden, the Netherlands; *Corresponding author: ate.dijkstra@icloud.com

A. Dijkstra, H. Kazimier-van der Zwaag, W. Kooistra, G. Swildens. Fox Hunting Game: User evaluation of an exergame for community-dwelling older adults to support their mobility. Gerontechnology 2018;17(2):68-76; <https://doi.org/10.4017/gt.2018.17.2.001.00> Many countries in the world have to do with an aging population. This article describes the evaluation study of an exergame to support community-dwelling older adults to stay mobile. In this study, we focused on two aspects of mobility: the extent to which a person is able to move about unaided in- and outdoors, and the extent to which a person is able to adopt a position appropriate to a certain activity. Exergaming can be defined as an experimental activity, which involves playing exergames that require physical exertion, or movements that are more than sedentary activities, and include strength, balance, and flexibility activities. The aim of the study was to evaluate if the exergame is an effective method for training community-dwelling older adults to stay or become self-reliant, mobile and socially active for as long as possible. This research project was designed as a panel study to supply data at three points in time. Overall, the conclusion can be that the study shows successful improvement of specific physical function due to the exercises of the game and mini-games. These physical functions are related to, among others, coming from stand to sit, standing unsupported, and getting in/out bed.

Keywords: Alzheimer's disease, dementia, serious games, computer-assisted

INTRODUCTION

Many countries in the world have to do with an aging population. With increasing age, the possibility exists for a progressive decline in physical function what can lead to problems with regard to daily activities¹. Especially among community-dwelling older adults, moving in- and outdoors is a fundamental prerequisite for taking care of daily activities, for independent living and social participation^{2,3}. The frequency of going outdoors is a good indicator of functional and psychosocial functioning among community-dwelling older adults⁴. The most common form of outdoor mobility is walking⁵. However, there is a decrease in outdoor walking when people get older, due to increasing mobility limitations and lack of company^{6,7}. To prevent impoverished older adults care, community-dwelling older adults living in the community should take preventions, especially regarding their mobility⁸. Two aspects of mobility are important in this: the extent to

which a person is able to move about unaided in- and outdoors, and the extent to which a person is able to adopt a position appropriate to a certain activity⁹. Both aspects of mobility make it possible for community-dwelling older adults to do their normal daily life activities in and around the house: e.g. doing errands, gardening, visiting family members and friends, and prepare household activities such as eating, washing dishes, and changing bed linen. This requires that they have resources that enable them to invest in prevention. Prevention is required to ensure that people retain their self-reliance as long as possible. It is therefore important to take the current daily activities of community-dwelling older adults as a starting point for developing eHealth technology.

Older people are generally less physically active than younger adults are. The main challenge is to find effective ways to support older adults to increase their physical activity to stay healthy, en-

ergetic, and independent². For this reason, an exergame has been developed in supporting community-dwelling older adults to stay as long as possible independent and social active. Exergaming can be defined as an experimental activity in which playing exergames that requires physical exertion or movements that are more than sedentary activities and include strength, balance, and flexibility activities¹⁰. A recent systematic review of the physical effect of exergames shows that exergaming seems to have a potential for improving health in the older adults¹¹. The reason to develop an exergame in promoting prevention regarding mobility is that exergames can be effectively used to reinforce compliance and alter behaviour through behavioural inoculation, leading to significant increase of correct in-game behaviour^{12,13}. The question was 'how community-dwelling older adults can be motivated to remain self-reliant'. Three basic preconditions (autonomy, competence and relatedness) should met in order to become self-motivated for something¹⁴. First, the feeling that community-dwelling older adults have chosen freely for something to do. So intrinsically motivated to do something, just because it is fun. Moreover, fun is inextricably linked to gaming¹⁵. Gaming offers community-dwelling older adults the possibility that they can better governed certain tasks. By their own willpower and drive, they become convinced to become more skilled and the newly learned becomes a new habit for them¹². This positive effect is seen as a welcome bycatch: physical functioning improves unnoticed. In addition, the need to belong, to feel themselves connected and to gain experience from their immediate environment¹⁶.

This project started with investigating the importance of prevention in older adults in relation to their mobility and independence. Outcomes of a literature study show that a fall affects and reduces the mobility of community-dwelling older adults. Whereby a fall can have serious consequences for the independence of someone. A fall can greatly be reduced by regular physical exercises. Therefore, doing more exercises that are physical could contribute to a prevention means to improve mobility for older adults in their wish to continue living independently at home¹⁷. Another outcome showed that relative inactivity of older adults could be the main cause of age-related muscle strength loss¹⁸. A multi-component exercise intervention program that consists of strength, endurance, and balance training appears to be the best strategy for improving gait, balance, and strength. Balancing training is effective in improving mobility, and the functional and static balance¹⁹. It reduces the chance of fall incidents and increases the chance of being able to function independently²⁰. The exercises found to maintain self-reliance were strength, balance,

reach out, and grab²¹. Based on the results of the preliminary literature studies, we started with the design assignments of the game and mini-games, carried out in co-creation with the future end-users. These future users were divided into two focus groups: those who lived independently at home (N=4, all females) and those who lived in a sheltered accommodation located in or near a care home (N=5; 4 females and 1 males). Both focus group participants offered comments and suggestions to improve elements in the game design. These data from both focus groups were analysed and used as input for Scrum sessions with researchers, educational technologists, and game designers²². After each session, observational data and players feedback (usability and feasibility) were analysed and led to a partial redesign or reconfiguration of the game^{23,24}. An exergame prototype was the result of design and redesign in co-creation with potential users.

But before the game can be brought to the market, it is necessary to prove conclusively that the exergame is an effective method for training community-dwelling older adults to stay or become self-reliant, mobile, and socially active for as long as possible. The following research question has given direction to evaluate if the exergame, called Fox Hunting Game, is an effective method for training community-dwelling older adults to stay or become self-reliant, mobile and socially active for as long as possible.

METHOD

Design

This research project was designed as a specific type of longitudinal study, namely a panel study. In panel studies, the same subjects are used to supply data at two or more points in time²⁵. Panel studies have the major advantage of establishing a time-sequence among variables, so that patterns of change, reasons for the change, and causal relations can be inferred²⁶.

Participants

To sample the panel, we were looking for community-dwelling people over 65, with the expectation that the Fox Hunting Game will provide the best results for this target group. Through the cooperation of two older adults care organizations, an invitation letter with information on the research was distributed in the area around eight of their care homes. At entry to the study, 21 community-dwelling women (mean age/SD: 79.1/7.58) and 12 men (mean age/SD: 78.3/7.97) participated in the panel. These participants lived independently at home or in a sheltered accommodation located in or near a care home. There was no significant difference in age between woman and men ($p=0.76$). All participants filled in an informed consent form.

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Figure 1. Impression of the 'village' world

Apparatus

To play the Fox Hunting Game, a camera-based input device, the Microsoft Kinect, was used to enable the player to control the game with body postures and movements with feet and arms. The Kinect was connected to a personal computer running Windows⁷. Body postures and movements were stored after every session in a relational database hosted on the computer, providing immediate feedback on game play. All player sessions were sent via an online connection to the dashboard server. A 40-inch widescreen monitor was mounted on a movable carriage together with the personal computer, the Kinect sensor, and an audio set. Participants viewed the display from a distance of approximately 2.5 m, dependable on the mounting angle of the Kinect.

Procedure

The Fox Hunting Game, based on the game of goose, is a virtual game where players try to find the fox (Figure 1). Players move standing on a large screen in a virtual world, which consists of a small street, a museum, and a zoo. The objective of the game is to find the fox three times. The players can find the fox by walking to the location of the fox with their own pawn. Using a Kinect Sensor,



Figure 2. Picture of one of the mini-games

the player moves through the game the number of steps according to the number thrown by the dice. These steps are put through a knee to move up into a position of 45 degrees. When the players arrived at a place in the game where a choice must be made for straight, left or right, the player indicates this by making arm movements. Additional steps can be earned by playing on of the three mini-games (Figure 2). These mini-games are related to reaching and grasping, balance and

doing squats. Multiple players with a maximum of four players can play the game (Figure 3). This makes playing the game a social activity with as aim an improvement in mobility²⁷.

The participants played the Fox Hunting Game in a care home near their house. The game was played in a small group one hour per week, 16 weeks long. After a once-only instruction on the workings of the game, the participants logged in with upfront provided account credentials, using a mouse and keyboard. The participants used hand gestures to start the game. At the beginning (T0), middle (T1) and at the end of these 16 weeks (T2), a questionnaire was administered to the participants.

Instruments

A questionnaire was used to answer the research question posed. The questionnaire consisted of the following measurement instruments:

- The Berg Balance Scale's utility includes grading different patients' balance abilities, monitor functional balance over time, and patients' responses to treatment. The Berg Balance Scale is a test of 14 items; it is performance based and has a scale of 0-4 for each item (higher score for independent performance) with a maximum score of 56. The Berg Balance Scale is considered the gold standard assessment of balance with good intra-rater reliability and inter-rater reliability and good internal validity²⁸.
- The Morton Mobility Scale (DEMMI) consists of 15 mobility items that are administered by therapist observation of physical performance, e.g. problems with mobility, exercise, and daily activities. The therapist observes each item whether a person can perform the activity independently (score 0, 1 or 2). A high score corresponds to a high degree

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Figure 3. One of the participants of a panel group in action

caused by several chronic conditions, (2) establish changes in disablement over time, (3) differentiate more accurately between degrees of disability, and (4) improve the assessment of the need for professional care³⁰. The GARS consists of 18 items and 5 response categories. The items refer to what respondents are able to do and not to their actual performance, which is a very important distinction³¹.

- The Maastricht Social Participation Profile (MSPP) consists of four indices: consumptive participation, formal social participation, informal social participation-acquaintances

of mobility. The DEMMI has suitable psychometric properties for application in community-dwelling older adults who require informal care²⁹.

and informal social participation-family. Each index measured diversity and frequency of participation. The MSPP has a good validity and acceptable reproducibility. Its distinguishing features are its focus on actual social participation and the possibility to calculate both diversity and frequency scores³². We used in our questionnaire parts from the MSPP, which measures

- The Groningen Activity Restriction Scale (GARS) has been applied in several studies in the Netherlands. It has proven to be a very useful instrument: it makes it possible to (1) describe more precisely the severity of the disablement

Table 1. Berg balance scale

Berg Balance Scale	T0-T1 (n=33)		T1-T2 (n=33)		T0-T2 (n=26)	
	8 play sessions		8 play sessions			
	T0: M(SD)	p<0.05	T1: M(SD)	p<0.05	T2:M(SD)	p<0.05
1. Sitting to standing	3.27 (1.04)	n.s.	3.45 (0.67)	n.s.	3.38 (0.70)	n.s.
2. Standing unsupported	3.58 (1.17)	n.s.	3.88 (0.42)	n.s.	3.81 (0.80)	n.s.
3. Sitting with back unsupported but feet supported on floor or on a stool	3.88 (0.42)	n.s.	3.97 (0.18)	n.s.	4.00 (0.00)	n.s.
4. Standing to sitting	3.52 (0.71)	0.030	3.76 (0.44)	n.s.	3.77 (0.43)	n.s.
5. Transfers	3.42 (0.97)	n.s.	3.67 (0.60)	n.s.	3.69 (0.62)	0.047
6. Standing unsupported with eyes closed	3.45 (1.09)	n.s.	3.64 (0.65)	n.s.	3.54 (0.86)	n.s.
7. Standing unsupported with feet together	3.27 (1.33)	n.s.	3.33 (0.96)	n.s.	3.42 (0.86)	n.s.
8. Reaching forward with outstretched arm while standing	3.24 (1.30)	0.041	3.70 (0.68)	n.s.	3.85 (0.37)	0.01
9. Pick up objects from the floor from a standing position	3.48 (1.18)	n.s.	3.76 (0.75)	n.s.	3.65 (0.85)	n.s.
10. Turning to look behind over left and right shoulder while standing	3.36 (1.06)	n.s.	3.27 (1.04)	0.009	3.65 (0.56)	n.s.
11. Turn 360 degrees	3.36 (1.19)	n.s.	3.36 (1.17)	n.s.	3.31 (1.29)	n.s.
12. Placing alternate foot on step or stool while standing unsupported	2.55 (1.52)	0.001	3.52 (0.80)	n.s.	3.50 (0.86)	0.000
13. Standing unsupported one foot in front	1.76 (1.60)	n.s.	2.15 (1.64)	n.s.	1.88 (1.63)	n.s.
14. Standing on one leg	1.88 (1.69)	n.s.	2.06 (1.50)	n.s.	1.65 (1.50)	n.s.
Total score Berg Balance Scale	44.01(11.43)	0.004	47.49(7.17)	n.s.	47.12(7.10)	0.002

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Table 2. Morton mobility scale

Morton Mobility Scale (DEMMI)	T0-T1 (n=33)		T1-T2 (n=33)		T0-T2 (n=24)	
	T0: M(SD)	p<0.05	T1: M(SD)	p<0.05	T2:M(SD)	p<0.05
1. Bridge	0.76 (0.44)	n.s.	0.88 (0.33)	n.s.	0.88 (0.33)	0.043
2. Roll onto side	1.00 (0.00)	n.s.	1.00 (0.00)	n.s.	1.00 (0.00)	n.s.
3. Lying to sitting	1.88 (0.33)	n.s.	1.94 (0.24)	n.s.	1.96 (0.20)	n.s.
4. Sit unsupported in chair	0.94 (0.24)	n.s.	1.00 (0.00)	n.s.	1.00 (0.00)	n.s.
5. Sit to stand from chair	1.94 (0.24)	n.s.	2.00 (0.00)	n.s.	2.00 (0.00)	n.s.
6. Sit to stand without using arms	0.76 (0.44)	n.s.	0.79 (0.42)	n.s.	0.76 (0.44)	n.s.
7. Stand unsupported	0.88 (0.33)	0.044	1.00 (0.00)	n.s.	0.96 (0.20)	n.s.
8. Stand feet together	0.85 (0.36)	n.s.	0.85 (0.36)	n.s.	0.88 (0.33)	n.s.
9. Stand on toes	0.52 (0.51)	n.s.	0.52 (0.51)	n.s.	0.32 (0.48)	n.s.
10. Tandem stand with eyes closed	0.39 (0.50)	n.s.	0.45 (0.51)	n.s.	0.24 (0.44)	n.s.
11. Walking distance +/- gait aid	1.97 (0.74)	n.s.	2.00 (0.00)	n.s.	2.00 (0.00)	n.s.
12. Walking independence	1.64 (0.55)	n.s.	1.45 (0.62)	n.s.	1.36 (0.70)	0.083*
13. Pick up pen from floor	0.91 (0.29)	n.s.	1.00(0.25)	n.s.	1.08 (0.86)	n.s.
14. Walks 4 steps backwards	0.58 (0.50)	n.s.	0.64 (0.49)	n.s.	0.56 (0.51)	n.s.
15. Jump	0.51 (0.51)	n.s.	0.42 (0.50)	n.s.	0.24 (0.44)	0.022
Total score DEMMI	71.36(22.48)	n.s.	70.42(17.36)	n.s.	63.76(12.66)	n.s.

* p<0.10

Table 3. Groninger activity restriction scale

Groninger Activity Restriction Scale	T0-T1 (n=33)		T1-T2 (n=33)		T0-T2 (n=24)	
	T0:M(SD)	p<0.05	T1:M(SD)	p<0.05	T2:M(SD)	p<0.05
1. Dress yourself?	1.48 (1.00)	n.s.	1.42 (0.83)	n.s.	1.46 (0.93)	n.s.
2. Get in/out bed?	1.36 (0.74)	0.014	1.03 (0.17)	n.s.	1.04 (0.20)	0.022
3. Stand up from chair?	1.21 (0.65)	n.s.	1.15 (0.51)	n.s.	1.08 (0.41)	n.s.
4. Wash face/hands?	1.12 (0.42)	n.s.	1.12 (0.55)	n.s.	1.17 (0.64)	n.s.
5. Wash/dry body?	1.91 (1.26)	0.039	1.58 (1.06)	n.s.	1.71 (1.08)	n.s.
6. Getting on/off toilet?	1.03 (0.17)	n.s.	1.09 (0.52)	n.s.	1.13 (0.61)	n.s.
7. Feed yourself?	1.12 (0.33)	n.s.	1.03 (0.17)	n.s.	1.00 (0.00)	n.s.
8. Getting around inside house?	1.30 (0.68)	n.s.	1.09 (0.29)	n.s.	1.00 (0.00)	0.026
9. Go up/down stairs?	2.18 (1.16)	n.s.	2.00 (1.20)	n.s.	2.25 (1.23)	n.s.
10. Walk outdoors?	1.67 (1.14)	n.s.	1.48 (0.94)	n.s.	1.42 (0.83)	n.s.
11. Take care feet/toenails?	2.79 (1.36)	n.s.	2.85 (1.37)	n.s.	3.21 (1.10)	n.s.
12. Prepare breakfast/lunch?	1.33 (0.78)	n.s.	1.21 (0.60)	n.s.	1.25 (0.74)	n.s.
13. Prepare dinner?	2.24 (1.39)	n.s.	2.12 (1.34)	n.s.	1.96 (1.30)	0.031
14. Light cleaning?	1.91 (1.21)	n.s.	1.70 (1.05)	n.s.	1.58 (1.06)	0.031
15. Heavy cleaning?	3.03 (1.31)	n.s.	3.06 (1.30)	n.s.	3.33 (1.09)	n.s.
16. Wash/iron clothes?	2.18 (1.31)	n.s.	2.33 (1.38)	n.s.	2.46 (1.41)	n.s.
17. Makes beds?	2.70 (1.36)	n.s.	2.82 (1.40)	n.s.	2.88 (1.33)	n.s.
18. Do shopping	2.09 (1.31)	n.s.	1.76 (1.09)	n.s.	1.88 (1.30)	n.s.
Total score GARS	32.67(12.55)	n.s.	30.85(9.60)	n.s.	31.79(8.53)	n.s.

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Table 4. Maastricht social participation profile

Maastricht Social Participation Profile	T0-T1 (n=33)		T1-T2 (n=33)		T0-T2 (n=24)	
	T0: M(SD)	p<0.05	T1: M(SD)	p<0.05	T2:M(SD)	p<0.05
Subscale A. Undertaking Activities						
1. Have you taken part in organized sport or physical activity such as an exercise class or swimming session at local pool?	2.09(1.04)	n.s.	2.24(1.23)	0.038	2.29(0.96)	n.s.
2. Have you taken part in a club, interest group or activity group, church or other similar activity?	1.82(0.88)	n.s.	1.87(1.13)	n.s.	1.67(0.92)	n.s.
3. Have you been to a cultural or educational event such as the cinema, theatre, museum, talk or course?	1.27(0.52)	n.s.	1.21(0.49)	n.s.	1.13(0.34)	n.s.
4. Have you eaten out?	1.61(0.56)	n.s.	1.67(0.69)	n.s.	1.71(0.81)	n.s.
5. Have you been out to a pub, café or tearoom?	1.39(0.61)	n.s.	1.42(0.66)	n.s.	1,21(0.51)	n.s.
6. Have you been to a public event?	1.03(0.17)	0.033	1.24(0.50)	n.s.	1.25(0.44)	n.s.
7. Have you taken part in an organized games afternoon or evening? For instance, bingo, quiz or card games.	2.33(1.08)	0.042	1.82(1.01)	n.s.	1.92(1.10)	0.043
8. Have you been on a day trip organized by a club or society?	1.21(0.49)	n.s.	1.06(0.24)	n.s.	1.13(0.34)	n.s.
9. Have you carried out committee work for a club, society or group?	1.21(0.49)	n.s.	1.30(0.73)	n.s.	1,21(0.59)	n.s.
10. Have you done any organized voluntary work?	1.06(0.24)	0.002	1.52(0.87)	n.s.	1.21(0.59)	n.s.
Subscale: B. Contact with friends or acquaintances						
11. Have you phoned, written, e-mailed or chatted to friends or acquaintances?	2.21(1.34)	0.013	2.61(1.35)	n.s.	2.75(1.39)	0.026
12. Have any of your friends or acquaintances called in to see you?	2.06(1.08)	n.s.	2.03(1.10)	n.s.	2.46(1.22)	n.s.
13. Have you called in to see anyone from your friends or acquaintances?	1.76(1.03)	n.s.	1.76(1.00)	n.s.	1.92(1.06)	n.s.
14. Have you done something away from home with a friends or acquaintances that required considerable physical effort, such as walking or cycling?	1.61(0.79)	n.s.	1.39(0.70)	0.010	1.83(1.17)	0.038
15. Have you done something away from home with a friends or acquaintances that required little physical effort, such as taking a car trip or going out for a cup of tea or drink?	1.30(0.53)	n.s.	1.36(0.74)	n.s.	1.42(0.83)	n.s.
16. Have you offered any of your friends or acquaintances practical help, such as doing the shopping, giving them a lift, doing odd jobs, or filling in forms?	1.36(0.74)	n.s.	1.39(0.86)	n.s.	1.38(0.65)	n.s.
17. Have you given a friends or acquaintances advice or tips?	1.97(0.77)	n.s.	1.88(0.96)	n.s.	1.83(1.01)	n.s.
18. Have you supported a friends or acquaintances when they needed someone to talk to?	2.06(0.90)	n.s.	2.15(0.97)	n.s.	2.21(1.10)	n.s.

frequency and diversity of social participation both in 'Undertaking Activities' and with regard to 'Contact with friends or acquaintances'.

- The Fall Efficacy Scale - International (FES-I) is a questionnaire that assesses fear of falling (FOF), defined as an ongoing concern about falling, which ultimately limits the performance of activ-

ities of daily living^{33,34}. In order to minimize the assessment burden and increase the acceptability, a 7-item version of FES-I (short FES-I) has also been developed, validated and recommended for the community-dwelling older population³⁵.

- Wellbeing. Three self-designed questions were added to the questionnaire, about how the participants feel themselves after playing the game: (1) in contact with peers, (2) physical condition, and (3) confidence in own ability.

Analysis

Data obtained from the questionnaire were analysed quantitatively, using the Statistical Package for the Social Sciences version 21.0. Outcomes were calculated using descriptive statistics, cross-tabulations, and independent sample t-tests. A level of $P < 0.05$ was considered statistically significant.

RESULTS

Although most items showed no significant improvement in time, the Berg Balance Scale revealed a continues (significant) improvement for the items 'Reaching forward with an outstretched arm while standing', 'Placing alternate foot on step or stool while standing unsupported', and sum score on T1 and T2 compared with T0. The items 'Standing to sitting' (T0-T1), 'Transfers' (T0-T2), and 'Turning to look behind over left and right shoulder while standing' (T1-T2) revealed also a significant improvement (Table 1).

The Morton Mobility Scale, to assess physical performance, gave no significant outcomes in time, with the exception of the items 'Bridg' (T0-T2), 'Stand unsupported' (T0-T1), and 'Jump' (T0-T2) (Table 2).

The Groninger Activity Restriction Scale showed only significant improvement between T0 and T2 on the following daily activities: 'Get in/out bed', 'Getting around/inside house', 'Prepare dinner', and 'Light cleaning'. The activity 'Wash/dry body' revealed on T1 a significant improvement (Table 3).

The Maastricht Social Participation Profile showed on the subscale 'Undertaking activities' a significant improvement between T0-T1 on three of the 10 items. Between T1-T2 findings revealed only on one item a significant improvement and between T0-T2 a significant improvement was found on the item 'Have you taken part in an organized games afternoon or evening'. Furthermore, on the subscale 'Contact with friends or acquaintances' we found a significant improvement on the items 'Have you phoned, written, e-mailed or chatted to friends or acquaintances?' (between T0-T1 and T0-T2) and 'Have you done something away from home with a friends or acquaintances that required considerable physical effort, such as walking or cycling?' (between T1-T2 and T0-T2) (Table 4).

No significant improvements were found on both the item and total score of the Fall Efficacy Scale on T1 and T2 compared with the score on T0. With regard to how the participants feel themselves after playing the game, we saw a significant improvement between T1 and T2 on the question 'How do you feel after playing the game with regard to confidence in your own ability?'

DISCUSSION & CONCLUSION

Discussion

The evaluation study, in which the final version of the prototype of the game was used, affirms the game capacity to act as a tool to improve physical activity, e.g. walking around and inside the house. This was in line with previous studies suggesting that serious games could integrate the therapeutic repertoire to increase the level of physical activity³⁶. In addition, the exercise program with the Fox Hunting Game has led to improvements in the field of social activities and confidence in their own abilities. Further, the game has a potential for home or institutional use, since it allows the training of physical and social functions for community-dwelling older adults living at home or in a sheltered accommodation located in or near a care home.

As mentioned earlier, the Fox Hunting Game is a game that you play with others. Wanting to be the best was not only found in the behavior of the direct players of the game. Even among those who have played the game in many co-creation sessions, the competition element remains present. Another remarkable finding was the fun factor of playing the Fox Hunting Game. The players were encouraged from the side-line by teammates and spectators or received comments on playing the game. This emphasis on fun and teamwork gave a welcome bycatch: the physical functioning of the players improved unnoticed.

One aspect to consider is the safety of the players with respect to performing the exercises. In the evaluation study, we saw that some players overestimate their own abilities and skills. This means that an intake conversation in advance about this safety aspect by a physiotherapist or exercise therapist is necessary.

Conclusion

The study demonstrates that the Fox Hunting Game contributes in training community-dwelling older adults to stay or become self-reliant, mobile and socially active. The Groninger Activity Restriction Scale showed an improvement in self-reliance in the following two parts: independently get out of bed and walk around independently at home. Looking at the results of the Fall Efficacy Scale, the game showed no association with the occurrence of falls. Furthermore, im-

perceptible improvement takes place in physical function. Improvements that can be attributed to the exercises which are built into the game and mini-games. To conclude, in the evaluation study we sought for an answer to the question if the Fox Hunting Game is an effective method for training community-dwelling older adults to stay or become self-reliant. Although the long-term effects of the exergame are not evaluated, this evaluation study evokes the image that the Fox Hunting Game helps to realize the wishes of many community-dwelling older adults to stay mobile and socially active^{27,37}.

Limitations

The results of this study so far must be interpreted within the context of the following limitations. The project showed that community-dwelling older adults is a heterogeneous group and diverse in terms of physical-, cognitive and social functioning. This heterogeneity among the older adults will have to be taken into account in the further development of the prototype into a market conform product.

The evaluation study is a first step in testing the effectiveness of the game. Despite the first promising results, we cannot make statements concerning the sustainability in the long-term regarding the improvements in the area of physical and social activities. Serious games have been proved to produce transient effects³⁸. These effects may be due to an initial increase of motivation. In or-

der to ensure sustainability, further research has to evaluate which game effects support long-term motivation and engagement of community-dwelling older adults in playing the Fox Hunting Game. To keep motivated players, the game will need to connect more with the specific life situation of community-dwelling older adults in relation to their physical and social wishes and needs. Limitations include the use of a small convenience sample of community-dwelling older adults in the evaluation study. Therefore, additional research with a longitudinal design with a control group is required for a better understanding of the long-term effect of playing the game on the improvements of physical and social activities of the community-dwelling older adults.

Further research

Finally, the following recommendations for further research can be formulated:

1. The design of appropriate mini-game concepts to improve the effective and enduring enhancement of all components of the game.
2. The investigation of the use of the game for other specific target groups than community-dwelling older adults.
3. A longitudinal study might help to explore the effectiveness of the game interventions on the long-term.
4. The investigation of the market position of the Fox Hunting game in order to write a business case.

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