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Abstract

This report consolidates the main results of the second 10-month field trial phase of the EnterTrain gaming platform in Austria and the Netherlands. The objective of EnterTrain is to enhance the health and quality of life of independently living older adults by motivating to follow physical training by digital exergames. The development of the EnterTrain system followed several steps, always focused on assessing and including the needs and preferences of end-users. The field trial phase aimed to gather technical and users' feedback in regards to the EnterTrain system, the games and the digital mobility model. Twenty participants in each country, Austria and the Netherlands took part in a 10-month trial phase where the games were installed in their homes. Over the course of one year (between May 2018 until March 2019) test users gave valuable feedback and insights in regards to their gaming experience, the usability of the platform, as well as the (subjective and objective) impact on their health and wellbeing.

Keyword List Exergames; Ageing; End-User Involvement; Field Trial; Evaluation Design

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| Version 2.0 | 2017-10-14 | Final version of User Report I after feedback from partners |
| Version 3.0 | 2019-03-15 | Integration of results Pilot II |
| Version 4.0 | 2019-03-29 | Final version of User Report II after partner feedback |

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# 1 Introduction

This report consolidates the main results of the second 10-month field trial phase of the EnterTrain gaming platform in Austria and the Netherlands. The objective of EnterTrain is to enhance the health and quality of life of independently living older adults by motivating to follow physical training by digital exergames. The development of the EnterTrain system followed several steps, always focused on assessing and including the needs and preferences of end-users. The field trial phase aimed to gather technical and users' feedback in regards to the EnterTrain system, the games and the digital mobility model. Findings from the first pilot phase impacted upon technical features and evaluation design for the second field trial phase.

Before this second field trial phase started, a large scale user needs analysis was conducted in Austria and the Netherlands followed by a short first trial phase including 4 participants in both countries over the course of 8 weeks between May and July 2017. Findings from the survey (questionnaire and interviews) and focus group discussions were reported in D1.1 "Catalogue of requirements". Findings from the first trial phase are discussed in D2.1 "First User Report".

Twenty participants in each country (Austria and the Netherlands) took part in a 10-month trial phase where the games were installed in their homes. Over the course of one year (between May 2018 until March 2019) test users gave valuable feedback and insights in regards to their gaming experience, the usability of the platform, as well as the (subjective and objective) impact on their health and wellbeing.

The gaming platform included seven different games, which aimed to train and improve both physical and mental capabilities. The six games were Puzzle, Bingo, Arithmetic, Fox, Deep Sea Diver and Mole Game.

The report discusses the evaluation methodology in Chapter 2, especially the applied methods. Chapter explains the sample in Austria and the Netherlands, as well as the Drop Outs during the second field trial phase. Additionally, short descriptions for each test user are added. Chapter 4 analyses the quantitative data from the survey and compares findings from each country. Chapter 5 discussed the usability of the EnterTrain gaming platform by presenting results for each game individually and some of the main features including the scoring system. Chapter 6 presents main results from the mobility assessments recorded throughout the trial phase. Lastly, chapter 7 discusses lessons learnt from this project and chapter 8 concludes this report with the main results.

# 2 Methods

In the second test phase, 40 participants aged 65 years and older tested the EnterTrain gaming platform, which was installed in their homes. Over the course of 10 months between May 2018 and March 2019, 20 participants in Austria and 20 participants in the Netherlands gave crucial feedback and input in regards to technical requirements. Empirical material used for the analysis consist of qualitative in-depth interviews and focus groups with test users during the trial phase as well as participant observations, and quantitative Pre-Post Questionnaire. Observations during the initial installations of the gaming system contribute to a better understanding of how the participants understand and perform ideas of staying active and in good shape.

The evaluation focused on four main topics:

1. Game use and integration into daily life
2. Impact on subjective and objective health and wellbeing
3. System usability
4. Feedback regarding the research participation.

The applied methods included 1) a baseline study (short quantitative survey about the personal background of test users), 2) quantitative Pre-Post Questionnaire, 3) mobility assessment tests, 4) qualitative problem centered interviews, and 6) focus group discussions in both countries.
Baseline interviews aimed at examining the current health status of the respondents and gathering background information such as daily routines and physical activities. Moreover, problem-centered interviews focused on the user's experience of the platform including its usability, the platform's impact on subjective and objective health as well as the feedback regarding the research participation. Interviews were conducted in two to three-month intervals.
Furthermore, focus groups were conducted with participants which aimed at facilitating a discussion among test users. Questions involved topics like daily experiences with the platform and playing the games and usability of the platform. All interviews were conducted by trained interviewers in the homes of the participants. The three focus groups in Vienna took place in July and November 2018 as well as in February 2019 at the Department of Sociology in Vienna as well as the facilities of the Samariterbund Office. In the Netherlands two focus groups took place in September in Nijmegen and in October 2018 in Son en Breughel.

All data was anonymized, the interviews were transcribed verbatim and analyzed using thematic coding according to Flick (1995).

The Pre-Post Questionnaire served as an opportunity to gather personal information before and after the intervention period to see what changed in the test users point of view. Therefore, Likert-Scales were used to assess basic health related information and information about the use of and attitudes towards ICTs.
Over the course of the ten months' testing period, users were invited to give feedback about the game use, the system usability, the impact of playing exergames on their health and mobility and generally their participation in the research. As applicable in Figure 1 below test staff visited users quite frequently from SOC and CogVis in Austria and NFE and SIL in the Netherlands.
All results and implications from the first and second test phase impact upon changes in regards to the technical design of the EnterTrain platform.

| | | AT | | | | NL | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Technica | Physio | Socio | Technica | Physio | Socio/NFE | | |
| m1 | **November 2017** | X | | X | | | | Tracking system installation | Mobility Data Export @every assessment |
| m2 | **December 2017** | | | | X | | X | | |
| m3 | **January 2018** | | X | X | | X | X | | |
| m4 | **February 2018** | | X | | | X | | | |
| m5 | **March 2018** | | X | | | X | | | |
| m6 | **April 2018** | | | | | | | | |
| m7 | **May 2018** | X | X | X | X | X | X | Installation of games, questionnaire | |
| m8 | **June 2018** | | | X | | | X | Focus Groups, Single Interviews | |
| m9 | **July 2018** | | | | | | | | |
| m10 | **August 2018** | | X | X | | X | X | Questionnaire, problems with games (SIL?) | |
| m11 | **September 2018** | | | X | | | X | Single Interviews, Focus Groups | |
| m12 | **October 2018** | | | | | | | | |
| m13 | **November 2018** | | X | X | | X | X | Single Interviews, Questionnaire, problems with games (SIL?) | |
| m14 | **December 2018** | | | | | | | | |
| m15 | **January 2019** | | | | | | | | |
| m16 | **February 2019** | X | X | X | X | X | X | Single Interviews, Questionnaire & Focus groups, problems with games (SIL?) | uninstall of systems |
| | | | | | | | | | |
| | | | | | | | | | |
| | | **METHODS** | | | | | | | |
| | | **SOCIO** | | | | | | | |
| | | Questionnaire (standardised, 4x times) | | | | | | | |
| | | Single User Interviews 4x | | | | | | | |
| | | Focus Groups 3x | | | | | | | |
| | | | | | | | | | |
| | | **PHYSIO** | | | | | | | |
| | | Physical assessments 4x | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

Figure 1: Timetable of the second trial phase

## 2.1 Evaluation Methodology

**Baseline Study**
The baseline interview aims to gather information about the personal background and context of the participant before the testing phase started. However, this interview is not supposed to be a narrative or biographical interview. The Baseline Study assesses topics related to the study at the beginning of an intervention period to examine the current status of the subjects participating in the treatment and aims at gathering background information of the participants as well as quantifies certain health factors such as physical and cognitive fitness.

**Questionnaire**
A Pre-Post Questionnaire is used to compare selected phenomena before and after an intervention or treatment. Ary et al. (2014, 326) describe that "*the one-group pretest-posttest design usually involves three steps: (1) administering a pretest measuring the dependent variable; (2) applying experimental treatment to the subjects; and (3) administering a posttest*." The directly administered questionnaire is used to gather quantitative data about information given at chosen moments.

**Problem centered Interviews**

> *"The principles guiding a problem-centered interview (PCI) aim to gather objective evidence on human behaviour as well as on subjective perceptions and ways of processing social reality." (Witzel 2000, 1)*

The problem centered interview is distinguished by a (1) problem-centered orientation towards socially relevant problems which also characterizes the organization of processes of cognition and learning. Furthermore, the (2) object-orientation emphasizes methodical flexibility in face of the different necessities of the objects. The (3) process orientation focuses on the communication process. If the communication is focused reasonably and acceptably on the reconstruction of orientations and actions, the interviewees feel that they are being taken seriously. This faith motivates participants to remember and to be self-reflective (cf. Witzel 2000). The interview guideline is one part of the problem-centered interview. The guideline is a supportive device to remember main interview topics - not a standardized questionnaire. (cf. Witzel 2000).

**Focus Groups**

The focus group discussion is a qualitative research tool where four to at most eight people come together for about two hours to discuss a particular topic. The researcher takes also part in the discussion and sets an interview input, for example with a movie, photo or an interview question. Interview guidelines are also used for focus group discussions. As already mentioned above, the guidelines have the purpose to support the interviewer while conducting the interview. The goal of the focus group discussion is to bring up different perspectives to ensure a broad range of positions regarding the discussion topic (Schulz 2012).

# 3 Sample

In Austria the sample comprised fifteen female and five male users. In the Netherlands the sample consisted of 23 persons, 1 male and 16 female test users. In each country, a variation in sex and age was aimed for. Inclusion criteria included:

- Test users are not diagnosed with dementia, nor with depression within the last 12 months;
- People are living alone as another permanent person in the household would have messed up the data collected by the movement tracker;
- People are above the age of 65 years

Test users were contacted and recruited by project partners from NFE (National Foundation for the Elderly) in the Netherlands and from SAM (Arbeiter-Samariterbund) in Vienna, Austria. Potential users were first contacted via telephone or face-to-face meetings and oftentimes visited at home by NFE or SAM staff members. In Vienna at first only the Smariterbund was in charge of recruiting participants, this process turned out as difficult, because it was not easy to find people who are willing to participate. Therefore, workers from Sam, CogVis and the University of Vienna used personal contacts to (constantly) fulfill the sample criteria of 20 people. Therefore, personal contacts established prior to the research project proved very helpful in recruiting test users. In the Netherlands, NFE has done all the recruiting. It also turned out to be difficult to find the right test persons, so NFE approached a physiotherapist in order to help with the recruiting. The last participants to join were recruited via her.

In Vienna the age range of test users was 67 to 90 years. 15 female and 5 male test users participated in the study. Overall, most test users were very active and not in need of additional care support. However, one female test users (90 years) was more physically limited and used a walking frame in her home during the night.

The ages of the test users in the Netherlands varied from 65 to 92 years old. Overall most test users were quite active; some met each other on a weekly basis for tennis. The last participants who joined the project were limited in their mobility, and proved very happy with the system.

## 3.1 Drop Outs in Austria and the Netherlands

The sample in Austria was at the beginning quite fluid, some people wanted to participate at first, but decided not to do it in the beginning of the test phase. However, some people even decided to leave the research study after participating for a while.

During the test phase, seven participants decided to leave the project in Austria. The dropouts consist of six females and one male participants. Reasons for leaving the research study were surgeries (2 female participants), different expectations or antipathy to the games. The male participant, who left the study, rather wanted company than playing the games. For him, regular visits from a visiting service would be better.

In the Netherlands, the sample was quite steady in the beginning, but dropouts began because some people were too fit for the system to stay motivated to continue playing. One participant dropped out quite early in the project. After a while one participant, who really wanted to give his contribution to the studies, just could not be motivated anymore. NFE found out in their meetings with the participants that one participant had not been practicing at all. So she left the project. Unfortunately, one of the very enthusiastic participants died of cancer, and this meant that most of her friends, who had joined because of her, also lost interest in the project altogether.

NFE thus added three new participants through the help of a physiotherapist. These were participants, who were either rehabilitating or in need of physiotherapy and who needed extra movement. One of these participants thought she was too old to learn and did not want to participate any more after a few times. The two other participants are very happy with the system and extra exercises. In the Netherlands, the study was finished with 17 active participants.

## 3.2 Short Descriptions Test users

In the list below all 37 test users in Austria and the Netherlands are briefly described with regards to their age, health status and living situation.

### 3.2.1 Short Descriptions of Test users in Austria

- **Participant 1 is 75 years old and has been a widow for 7 years**. Before her retirement, she has worked as a pediatrician in her own practice. She has diabetes and blood pressure and is not fond of her obliviousness and decreasing calculation skills. The participant is busy walking her dog about five times per week, 1-3 hours a day and participating in LIMA ("Lebensqualität im Alter") course to maintain her good health and improve her responsiveness. She likes to have a house cleaner clean her windows, because she does not want to risk hurting herself by falling, especially on the first floor of her house. She still manages to perform all other household activities without any problems and drives her own car. She owns a computer, which she uses to send emails and look things up on the internet. Her family plays a big role in her life. She enjoys having her grandchildren over several times a week to cook for them and read to them. Participant 1 plays an active role in a parish, where she takes part in activities with children and takes the time to participate in the EnterTrain project to improve her coordination skills and because of her general curiosity towards innovation.
- **Participant 3 is 75 years old** and a former head of the design office in an armature firm, who is leading a very active life despite suffering from back pain. Some of the activities he takes part in include hiking, swimming and spending a lot of time at the Danube River in the summer, either on a paddleboat or meeting with friends at the sailing association where he is also a member. He doesn't get any formal or informal care support. Participant A uses a computer daily, mostly to write and edit articles for two magazines from associations that he is part of. These magazines are published quarterly. Since he has participated in Pilot Phase 1, he was eager to join the second test phase as well, to improve his mobility and because it was fun playing the games.
- **Participant 4 is 70 years old.** The former accountant worked in the payroll department before she stopped working due to suffering from cancer. Not being employed, she now feels under challenged, even though she spends much time watching her grandson on a regular basis. Despite her having cancer, she assesses her current health as relatively good. Therapy against cancer is wearing, especially on her mobility, since she is not able to move easily and feels pain in her back and legs after each therapy session. She manages to motivate herself by walking as much as possible, which makes her feel as if she made progress, health wise. Her family is very important for her, not only does she like to watch after her grandchildren and go to family celebrations, she also receives help in the household from her children. The EnterTrain project, according to her, is a good way to make improvements in mobility.
- **Participant 6 is a 78-year-old widow**, who has owned a fashion store in Vienna with her husband. After her husband died, she continued working until she was 77 to help her daughter run the store, before it became insolvent. She exercised throughout her whole life, going skiing in winter, swimming regularly, as well as attending aerobics courses twice a week and playing tennis. She still leads a very active life going jogging and doing exercises with a TV program, also going swimming and to the Sauna. She is in no need of any care support. In general, she assesses her health as good, despite the fact that she got a new knee and had issues with her spine in the past. She is in regular contact with her family and friends, especially her granddaughter, whom she lives with.
- **Participant 7 is 69 years old**, widower and living in a house in a small garden club in Vienna. As the former head of the Duty Free Shop and former facility manager at the airport near Vienna he was laid off at the age of 59, and worked in a metal processing industry part-time for a few years afterwards. He does not have any health issues. He plays tennis twice a week and attends gymnastics courses, goes skiing and hiking. Due to his active role in a parish, where he attends church services regularly and is a member of the parochial church council as well, he has many social contacts. In addition, he is in steady contact with his family, especially his daughter and siblings. He wants to participate in the EnterTrain project out of the belief that the project is a

good idea and wants to help the process of developing innovations, which help care for older people.

- **Participant 9 is 67 years old** and has worked in a psychiatric clinic until her retirement. She feels healthy even though she has high cholesterol and osteoporosis. She owns two dogs, which she walks frequently and likes to jog and ride her bike. She has quit the gym two years ago due to an audience she did not like, but now has a balance board at home for increasing her stability and balance, which makes her happy too. Participant 9 is in steady contact with her family (via telephone), and drives her car every two weeks to visit her sister and bring her food. Apart from her family, she has many social contacts, whom she meets up with very often, for example, a group of people, who she plays cards with every two days. She uses a tablet and a computer on a daily basis, knows how to use Windows 10, and likes to use and explore technology in general. That is also a reason, why she takes part in the study.
- **Participant 11 is an 90-year-old female widower,** who had a hip fracture a few years ago, and has been seeing a physiotherapist since. A (formal) caretaker visits her three times a week to do grocery shopping together (nowadays, she uses a cane when walking outdoors) or support her with cleaning and other household chores. She spends most of her time at home, reading and watching TV, as she cannot walk long distances and feels unstable and oftentimes unsafe when using public transportation. She uses a Tablet to read Emails, Google things and to do crosswords. She is looking forward to using the EnterTrain platform, since she has already participated in trial phase 1.
- **Participant 12 is a 72-year-old former teacher** and principal of an elementary school near Vienna. Having nine grandchildren, her week is full with babysitting and having grandchildren over to cook or play. She was diagnosed with diabetes and high blood pressure, but can handle both very well. Furthermore, she has had operations on both her feet due to hallux valgus, and still has issues with her left foot. She does gymnastics once a week, walks her son's dog almost every day for at least an hour and is a member of a choral society, whom she meets up with at least once a week. Taking part in cultural activities like going to the opera regularly or visiting concerts is important to her. Even though she doesn't spend much time at home alone, she is motivated to stay cognitively occupied, when she does.
- **Participant 14 is 68 years old** and a former salesperson and custodian. She assesses her health as rather bad due to constant backache, issues with the skin and not being able to breathe properly. Exercise is something she does not do regularly, since she also has hip problems, which get worse when she moves too much. She spends much time at home watching TV and reads a lot. She is in no need of formal care support, but has a friend who helps her clean high lying cupboards and windows from time to time. She is in contact with her son and likes to go to the coffeehouse with friends on a regular basis. She participates in the EnterTrain project because she is eager to learn how the platform works.
- **Participant 16 is 72 years old**, married and living with his wife and the family of his wife's son in a house consisting of two households. He still works for an architect as a self-employed construction planner and does voluntary service at a charitable organization. He owns a dog, which he walks every day and walks a lot in his voluntary work. Apart from working at the charitable organization, he spends much time sitting and working at the computer in his office at home. He suffers from shortness of breath, diabetes, and after a gastroscopy, carcinogenic substances were found in his stomach. He talks of himself as a very introvert person, who has problems making friends, but has a big family, as he is currently married to his sixth wife. As well as many other participants, he is very interested in social innovations, wants to test the EnterTrain platform and sees health benefits in participating.
- **Participant 17 is 70 years old** and married, but does not share an apartment with her husband. She used to work as an interpreter, translator and guide. She is currently suffering from tenosynovitis, but her health status has become better in the last three years due to new medication against her psoriasis, which she's been having since she was 19 years old. She is member of a private gymnastics group, which meets once a week in her living room. The group also goes for walks at the Prater Hauptallee in Vienna, as well as riding bikes when it is nice

outside. She spends much of her time with her husband, which he goes to the theatre or to concerts together with. She participates in the trial phase because she is curious about how the platform works and wants to do more exercise.

- **Participant 18 is a 69-year-old man**, who is living independently. He assesses his health as rather good without going into detail about it, but says he feels good. He goes for walks almost every day and walks about 30 to 35 kilometers a week. He does not receive any care support and usually spends the morning at home reading, watching TV and looking up things on the internet before he goes for his daily walk. He is very fond of his computer and the internet and likes to inform himself on any topic. He educates himself also by watching negotiations in court and the parliament and by going to conventions. He is in steady contact with his daughter, who also convinced him to participate in the study.
- **Participant 19 is 67 years old** and works voluntarily as a visiting service for older adults twice a week. He dances square dance every 14 days and loves to ride his Harley Davidson most of the time. He was diagnosed with bladder and prostate cancer nine years ago, which was operatively removed, and has severe diabetes but can handle it pretty well. Apart from square dance, he does not do much exercise and does not have many social contacts, he refers to himself as a ‘classic couchpotatoe’. He owns a Smartphone, Tablet and a computer, which he uses to organize his appointments and for looking up things on the internet.
- **Participant 20 is 73 years old** and works part-time in a coffeehouse. She works voluntarily as a reading mentor for children and gives private tuition. Once a week she participates in English lessons for older adults. She also enjoys spending time with this group outside of their formal English lessons, for example by going to the Christmas market or to concerts. Apart from that, she is a member of the gymnastics club and does line dance as well as playing a part in a theatre group. She has rare contact to her family, but she is happy to “have her own life now” and has her own friends, who she meets up with frequently.
- **Participant 21 is a 79-year-old female widow**, who is very active and engaged in physical and social activities. She does exercises at home once a day, goes swimming daily in the summer and/or walking regularly. She has been suffering from osteoporosis since she is 56 years old (then it was diagnosed). She is in close contact with her family, especially her daughter and granddaughter, which she invites for lunch every Sunday. She uses a Smartphone.
- **Participant 22 is a 76-year-old female widow**, who has been working as a bookkeeper in a bank her whole life. She now is retired and helps her daughter, who is self-employed (as a hotel owner) with bookkeeping and preparing breakfast. She has three grandchildren, who she spends much time with, either driving them to school or watching them after school. She meets her friends on a regular basis and is in touch with her family every day. She got to know about the project through another test user. She is motivated to play the games because she has troubles walking longer distances (because of her bad ankles and knees) and wants to do more exercise. She rarely does physical activities.
- **Participant 23 is a 75-year-old female** in good health; she has one daughter and two grandchildren with whom she is in close contact with. On a regular basis, she meets friends at the Heurigen or for other activities. Besides swimming, she also enjoys indoor activities including crosswords, reading or Sudoku. She uses a Smartphone but apart from that is not so much interested in new technical devices.
- **Participant 24 is a 85-year-old** former pharmacist, who has suffered many injuries in the past, such as, having fallen down the stairs, breaking various vertebrae and suffering from hallux valgus as well as neuropathy. Therefore, she considers her health as not too optimal, but knows how to supplement shortcomings, e.g. by using an escalator in her house when carrying heavy luggage. For exercise, she goes for short walks in the park nearby and moves a lot in her big house, also by using the ergometer. She also plays bridge in a bridge club at least three times a week and is in steady contact with her family, which lives nearby.
- **Participant 25 is a 74-year-old** woman, who is divorced, and has two daughters. She is very active and enjoys doing a lot of different sports including, running, swimming, cycling and hiking, the latter she and her daughter do together on weekends. She is also testing another AAL

software for a different project and enjoys social contacts, especially with friends she still has from school. She uses her Computer, the Internet and her Smartphone regularly.

- **Participant 26 is a 77-year-old** former public servant. She is active doing sports almost every day doing gymnastics and cycling on an ergometer. She spends her time watching television or meeting up with her boyfriend's family. She is also in contact with her own family, which consists of her brother-in-law and her nephew. She wanted to participate in the research to stay fit and healthy.

### 3.2.2 Short descriptions of test users in the Netherlands

- **Participant 02 is a woman of 82 years of age**. She has always worked in a sewing shop and owned her own coffeshop. Since her husband died, she has stayed in regular contact with her son and niece. She has had three strokes, but apart from that, she perceives her health as good. She is goes out a lot, doing sports and swimming regularly. She joined the project because she is always interested in trying new things and meeting other people.
- **Participant 03 is an 86-year-old widow**. She has children and grandchildren she can rely on for help. She was a sewer and has worked as a representative for sewing machines, demonstrating and promoting sewing machines in various shops. She does a lot of volunteering by being member of the client council in her parish and knitting sweaters for south African children. She also took care of her grandparents. Her health has deteriorated over the last four years. She suffers from rheumatism and has problems with her lungs, heart, kidneys and asthma. She was always very active, used to play handball, cycled, went jogging and rowing and played tennis. She had to stop doing most sports after the rehabilitation of her lung problems. She also had to stop cycling due to bad knees and joined the project to see if it would help her.
- **Participant 04 is a 78-year-old widow**. He has one son who lives close by and he moved closer to his son after his wife died. He has worked as a tax consultant for a tax consultancy office and with an accountant's firm before he retired. He never used a computer for work and now practices Tai Chi. Furthermore he joined a fitness club last year and practices a lot. He has had a heart attack some time ago and has problems with his ankles. He likes to watch sports, especially when the Olympics are on. Participant 04 joined the project to motivate himself to do more exercise.
- **Participant 05 is a 77-years-old widow** and has three children. She (and her husband) had a farm, which kept her busy aside from caring for her mother in law and her children. Now, since she is living in a house by herself, she likes to volunteer in a residential home, serving dinner and playing bingo. She leads a very active life. She walks an hour daily, goes swimming twice a week and in addition, she is going to many new places riding her bike on a daily basis. She has many friends. She wants to participate in the EnterTrain project out of the belief that the project is a good idea and wants to help NFE to develop innovative products and to improve her mobility skills too, to become fitter and staying healthy. In addition, she is very curious about this project and innovation in general.
- **Participant 07 is a 73-year-old female** who used to be kindergarden teacher and as such, she developed new modules and subjects for the school. After this, she started an MBO in care and wellbeing studies. Now as a volunteer, she is a chairperson for development work and palliative care at a weekend school and a hospital. During holidays, she tries to walk with sticks and swim a lot. She has joined gymnastics for elderly people and goes to Caesar therapy for breathing. She in contact with her brother and sister and she has one friend she goes for a walk with twice a week. She likes to go to concerts with another friend regularly
- **Participant 08 is a 75-years-old woman**, who worked as a nurse and later as the head of care administration for a home care organization. Now she is a volunteer for the walk-in house for cancer patients and for an elderly Union. Her health condition is okay, but she has become less fit over the last few years. She never really used to do sports. Lately, she started doing gymnastics after having had a frozen shoulder. She is in steady contact with her sisters and goes to have dinner every Friday with a group of friends

- **Participant 10 is a 65-year-old woman**, who retired last year after having worked for forty years as a social worker. She regularly visits her aunt, who lives in a care facility. She perceives her health as quite good, even though she has high blood pressure and a worn knee. She likes to go outside, work in the garden or go for a walk. She has joined a book club and like to knit. She likes to go to the theatre every few weeks as is in regular contact with her children. Her motivation to join the project was to help for the good cause and to have more sport activities herself.
- **Participant 11 is 67-year-old** woman who has worked as a guide for people with intellectual disabilities. She made ceramics with them, which were sold later on. Now she takes care of her mother and sometimes helps in her old job as a volunteer. Her health is good apart from some inflammation in her hip muscles. Her leg gives her trouble more often. During the project, she has fallen at some stage and hurt her head and leg. She used to do badminton, jazz ballet, aqua jogging, and folk dance. Five years ago, she started Pilates and if her leg does not hurt, she still likes to go on walks. She joined the program because she was invited to join and she likes to play games.
- **Participant 12 is a 92-years-old** female widow with two children. She lives in an apartment on the first floor. She worked at the Twentse bank in former Indonesia. She did a lot of interviewing work for her studies. Due to her father's work, she was raised in Indonesia, also during the second World War and nowadays she gets invited regularly to go to schools or to do interviews on the radio to talk about her experiences during that time. She indicates that her state of health is reasonable good given her age. She wants to participate in the EnterTrain project because there is a lot of complaining that too little is being done for the elderly and with this project, she wants to contribute to something new.
- **Participant 15 is a 66-years-old** female widow with two sons. She lives in an apartment on the first floor and uses always the stairs to stay fit. She starts working as a typist at a community home. Together with her husband and two sons, she had a butchery and a catering company. She is a volunteer at the local wellbeing organization. She drives elderly people to the hospital and dentists and she organizes a yearly (social) party for 200 older adults. She is a healthy woman who loves cycling (with her electric bike) and walking. Every Tuesday morning she trains one hour with a physiotherapist to stay fit and healthy. She has a good and close contact with her family, who lives nearby. She had read in the flyer of NFE about the EnterTrain project and immediately wanted to help the process of developing innovations to help care for older people.
- **Participant 16 is a 78-years-old** female widow with two children, a daughter and a son. Her husband died 9 years ago. She still has one brother (5 already died) with whom she is in contact. She has a lot of friends and social network, which keep her rather busy. She works as a psychotherapist, and still has clients. She does this on a volunteering basis. She also does volunteer work in her community where she visits older people (70 years and older). She is a healthy woman, but with a painful vertebra in her neck. She stays healthy by playing tennis a lot with her friends. She also participates in an exercise (gymnastic) club and does yoga. Further, she also participates every morning in the exercises, which are broadcasted on Dutch television (called 'Nederland in Beweging'). Encouraged by her best friend, she participates in the EnterTrain project. She wanted to stay healthy and fit.
- **Participant 18 is a 67-years-old** female. She has a daughter and many friends with whom she has regular contact. The last couple of years she is trainer for the course mourning and loss. She used to work as a geography teacher and she did development work in Africa. When she came back, she became a teacher for 'life questions and meaning'. Her whole life she is doing volunteering work for instance walking pilgrim tours (to Santiago the Compostello), volunteer of IVN institution for nature education and she is in a working group called spirituality. After 20 years, she stopped in the board of development work for 'Burkina Faso'. She also takes care of her grandchildren once a week. She is physically and mentally in good shape and plays tennis, goes cycling and walking on a weekly basis. Encouraged by her best friend, she participates in the EnterTrain project. Earlier she was a researcher herself so participating in the project she hopes to help other adults.

- **Participant 19 is a 74-years-old** is a female widow and has four children whom she often sees. She has been working as a nurse. Now she often takes often care of her grandchildren. She feels healthy, but as she gets older her physically conditions worsens. She still plays tennis weekly with her friends and has been playing field hockey until the age of 60 (from age of 30). Encouraged by her best friend, she participates in the EnterTrain project. She likes to help others and she has participated in other research projects and hopes she can help others with the outcome of the EnterTrain results.
- **Participant 20 is a 78-years-old** female widow with children. Before she got married she had her own business at home but stopped that when she had children. She followed a training to be a beautician. Now this is like a hobby to her, she still has some customers. She still plays tennis with her friends, goes on walks and cycles. She played volleyball and had skied for years. Encouraged by her best friend, she participates in the EnterTrain project. She likes to help others.
- **Participant 21 is an 80-year-old** female widow who has one son. She lives alone and needs her walking aid to go outdoors. Her son had asked us if we could think of something to get her out of a very passive way of living. Her parents had a small grocery shop that she worked in. After she got married and had children, she stopped working. Her physical health is deteriorating; she can no longer cycle or walk without a walking aid. Her mental health is fine. She has never done any sports, but she has walked and cycled a lot for fun. She has joined the project to become more mobile again and because she expected to like the gaming platform very much. She has very good relations with her family.
- **Participant 22 is an 83-year-old** female widow who used to be a first grade teacher. After she found out she had a chalk allergy, she turned her career to accounting for her father who had a business as a debt collector. In addition, she was an au pair in England and France. She had recently fallen twice and broken her knee in the process. She also suffers from COPD, dizziness sometimes and has palpitation. She does feel that her health is okay though. She has only done sports recreationally, including swimming and cycling. She joins the gym every week in the care home and walks the stairs if she feels that she needs some exercise. She walks with a stroller and does groceries with a car that takes her to the store. She has many social contacts with the people in the care home. However, she also has a lot of contact and help from her two children who live in the same city. In addition, she tries to keep in contact with her old friends. This is becoming more difficult, but she invests in trying to make it work. She joins many social events and gatherings in the care home. Her physiotherapist advised her to join the project.
- **Participant 23 is an 88-year-old** female widow. She used to work in accounting and later homecare combining care and cleaning. As a volunteer she has set up and run a community house and was a chairwoman and secretary for this community house. Her health is generally fine apart from some problems with her hip and her spine. She sometimes suffers from depressive thoughts, but that comes and goes and then she feels grateful for her capability to work in the garden and her loving family. She used to do many sports as a child, she ran very fast, used to play tennis and badminton up until well into her seventies. She receives professional help for cleaning and her children and grandchildren help her out with many things. The contact with her family is very good and warm. Her three children come to visit as much as they can and the grandchildren drop by occasionally as well. She has good contact with her friends, but loses many friends as well, which makes her feel sad. She joined the project on advice of her physiotherapist. She likes to stay alert to technical developments and help with scientific research.

# 4 Results from the Survey

Throughout the study, all participants filled in a questionnaire four times. They were asked to fill in questions about their current health situation and attitude towards technologies. In this section, the results of the first and last (fourth) questionnaire are illustrated. Additionally, the results are compared with the aim to evaluate possible changes in the way of responding during the test phase.

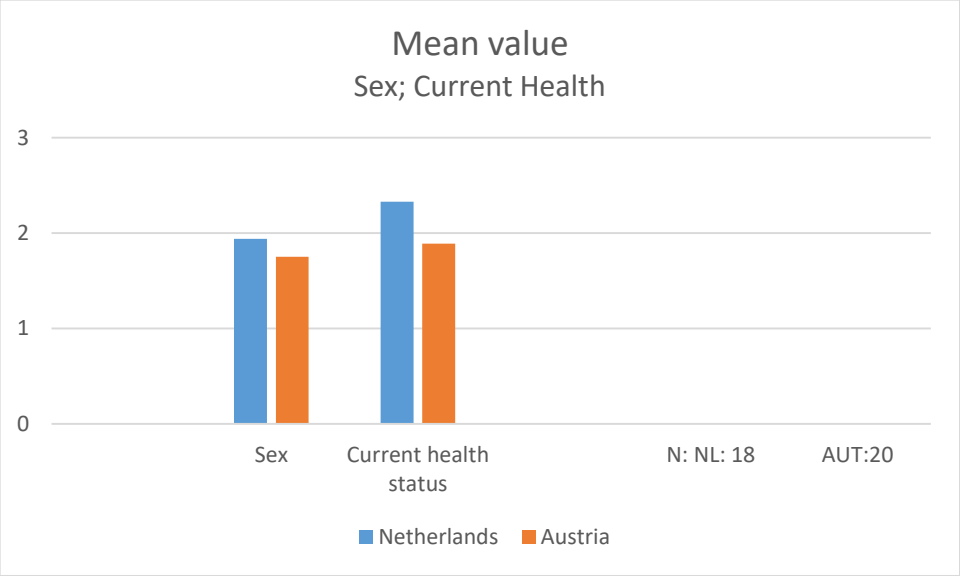


Figure 2: Mean Value of Sex and current health from Questionnaire 1

People in our sample were mostly female and most of them rated their current health status as *good* (1=very good; 2=good; 3=fair; 4=poor).

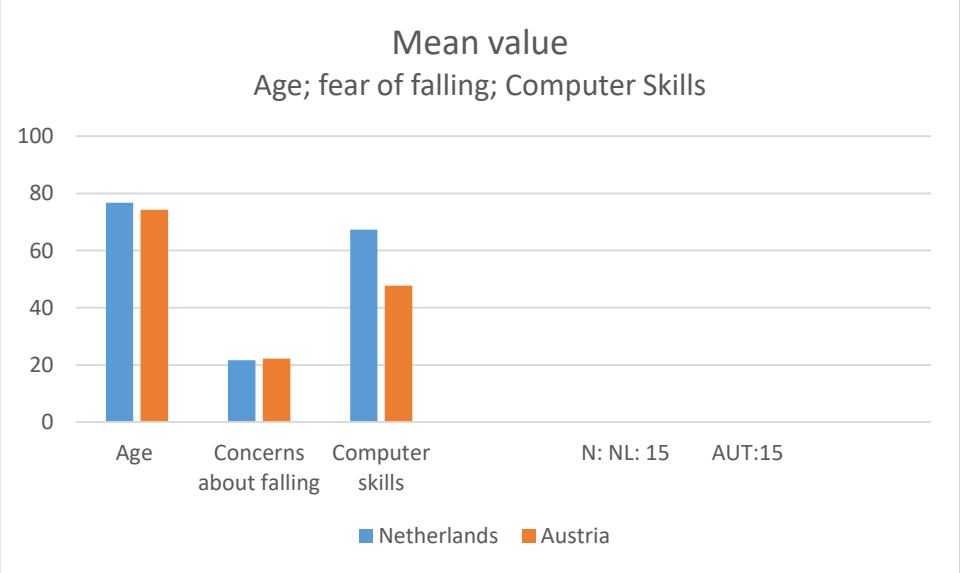


Figure 3: Mean Value of Age; Concerns to Fall and Computer Skills from Questionnaire 1

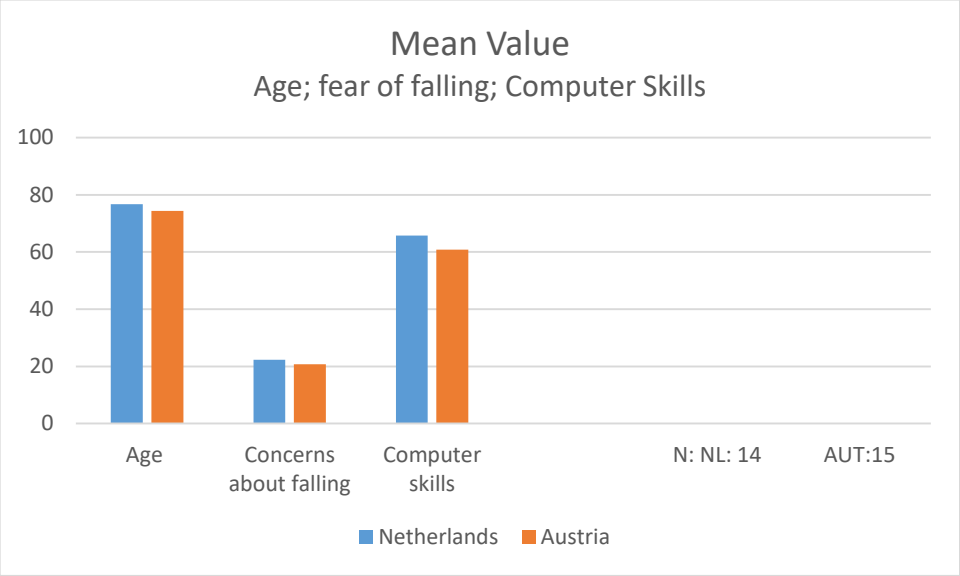


Figure 4: Mean Value of Age; Concerns to Fall and Computer Skills from Questionnaire 4

The graphs above summarize the mean values of three survey items, including the fear of falling while enacting certain activities and the self-rated computer skills.

By comparing the graphs above a change of the mean values of the self-perceived computer skills (scale from 0 to 100) throughout the field trial can be observed. People in Austria show a higher mean value (60,87) of computer skills at the end of the test phase than in the beginning (47,68).

Participants in the Netherlands recorded no changes in the mean value in regards to computer skills.

The fear of falling scale is based on 16 questions, asking whether the participants are concerned that they might fall while performing a particular exercise. The values range from 16 (no concerns while enacting any exercise) to 64 (concerns while enacting every exercise). No changes can be reported in the fear of falling compared to the beginning of the field trial.

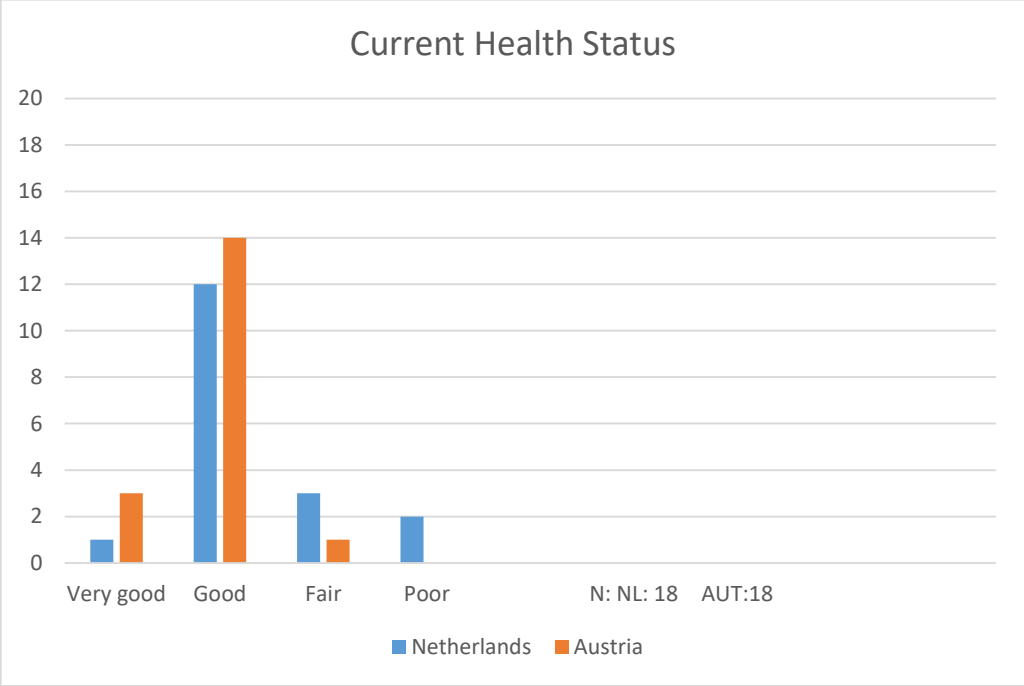


Figure 5: Rating of Current Health Status from Questionnaire 1

Most test users in Austria and the Netherlands perceived their current health status at the beginning of the test phase (questionnaire one) as *(very) good*.

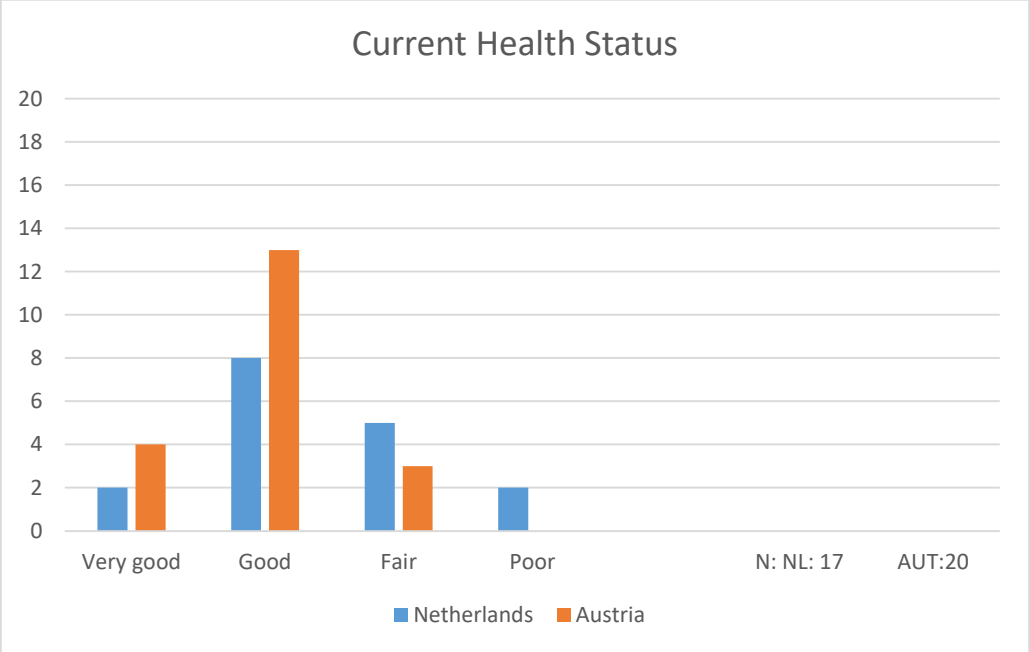


Figure 6: Rating of Current Health Status from Questionnaire 4

This did not change over the 10-month duration of the test phase, however, in the fourth questionnaire, participants from the Netherlands rated their current health status to a higher amount as *fair* as they did in the beginning of the study. Based on the graphs it can be concluded that people who participated in the study tend to consider themselves as rather fit.

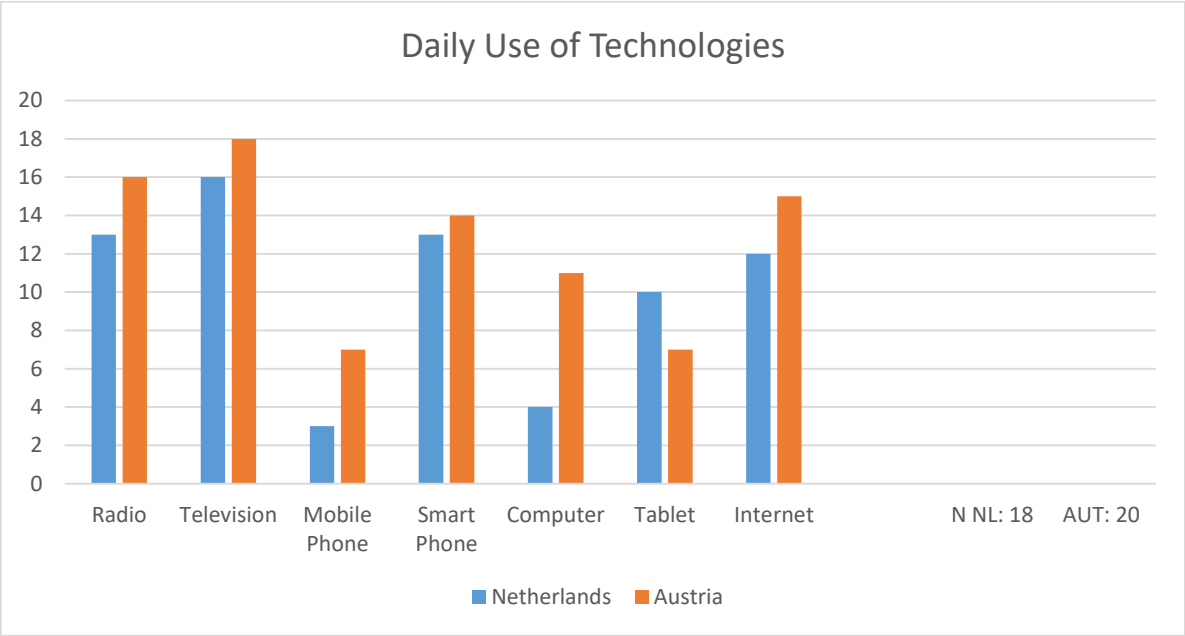


Figure 7: Daily Use of Technologies from Questionnaire 1

A high number of test users used a computer and/or a tablet daily. The use of a smartphone was very common as well in both countries.

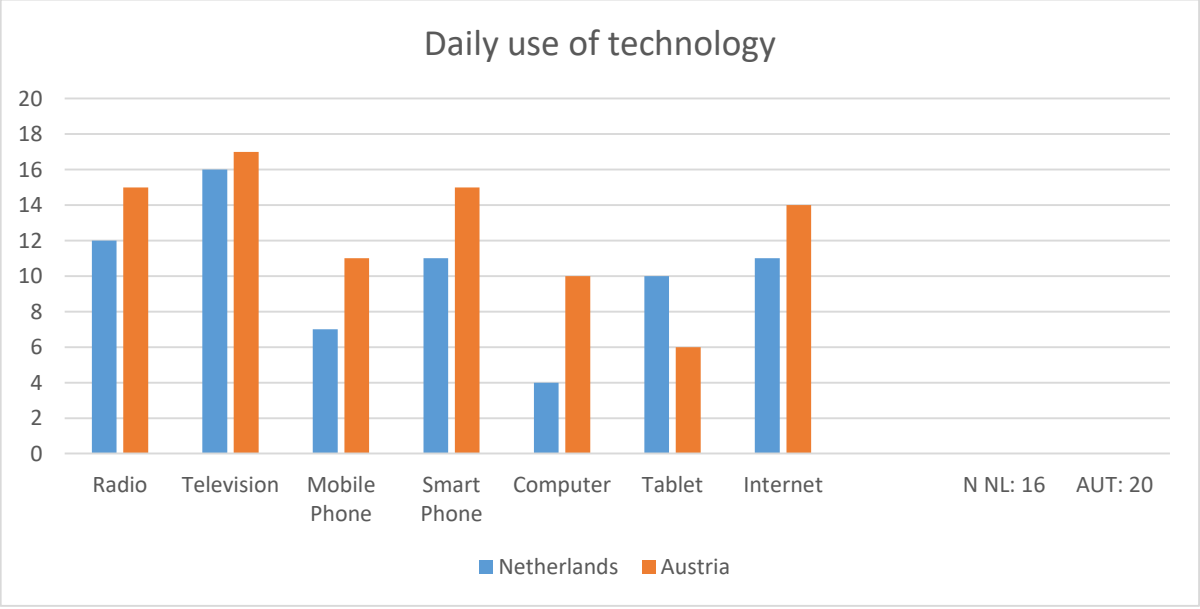


Figure 8: Daily Use of Technologies from Questionnaire 4

This did not change towards the end of the test phase. Participants still reported a frequent use of computers and tablets. In addition, one person in Austria reported a more frequent daily use of a smartphone and people in Austria and the Netherlands expressed a higher use of a mobile phones in the last questionnaire compared to questionnaire one.

Most participants were rather technology affine. These results were also confirmed as most test users had no (or very little) problems with using the platform. In regards to technical issues, many test users tried to solve problems on their own first before contacting project staff.

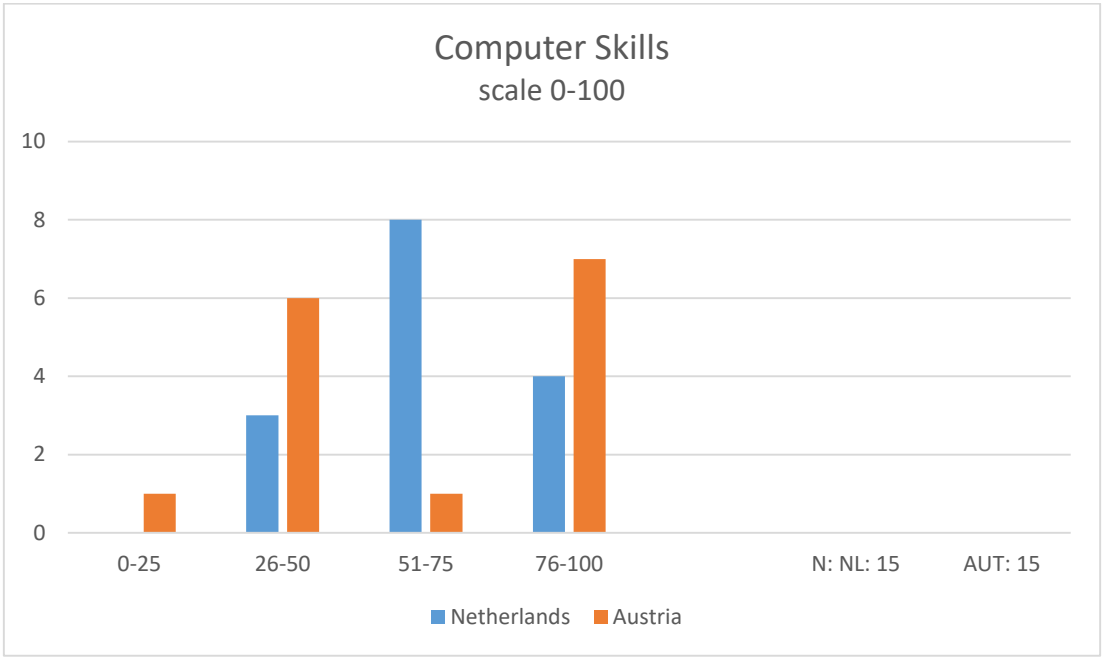


Figure 9: Self-rated Computer Skills from Questionnaire 1

Test users in Austria rated their computer skills as high (76-100) and thus better than test users in the Netherlands.

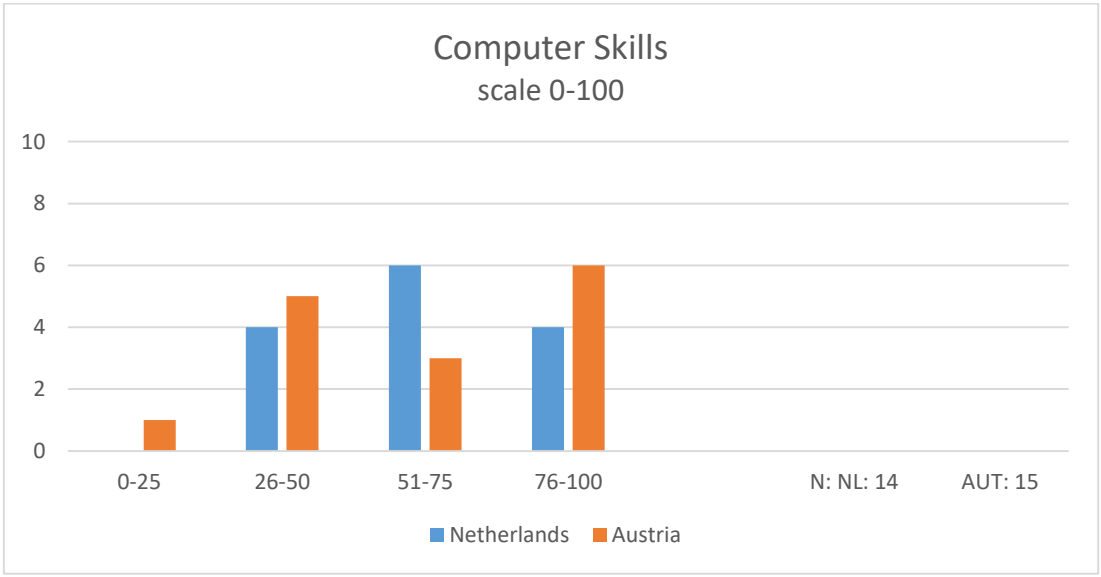


Figure 10: Self-rated Computer Skills from Questionnaire 4

In this case, a change throughout the test phase can be observed. People in the Netherlands view their own computer skills worse in the last questionnaire than they did in the first one (51-75). Additionally, participants from Austria reported higher computer skills in the middle range (51-75) and worse computer skills in the section 26-50 and 67-100.

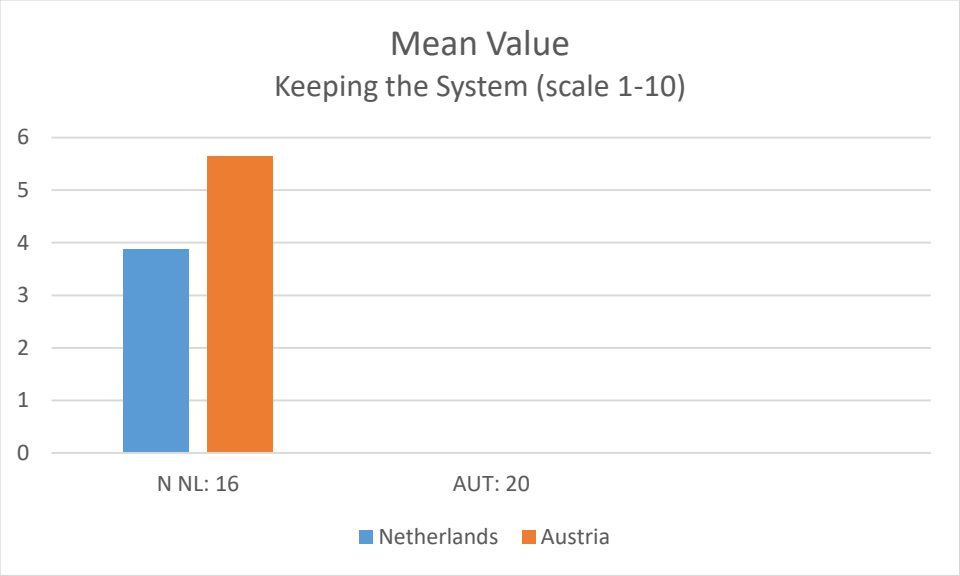


Figure 11: Mean Value of how much participants want to keep the EnterTrain System from Questionnaire 4

In the last questionnaire, people were asked to what extend they would like to keep the EnterTrain System after the testing period. Participants from the Netherlands reported a lesser wish of keeping the EnterTrain System (3,88) than people in Austria (5,65).

# 5 Usability

The following paragraphs discuss the user feedback regarding the EnterTrain gaming platform gathered throughout multiple interviews and focus group discussions in Austria and the Netherlands. First, each of the seven games including puzzle, bingo, arithmetic, fox, axolotl, mole and gardening, is discussed independently. Second, the function to view the personal score achieved while playing and sensor problems, focusing on how test users tried to solve those independently, are discussed. Third, the main technical improvements in regards to specific games and technical functionalities made after the first and throughout the second trial phase are summarized.

## 5.1 Puzzle

The puzzle game focuses on improving stability and mobility by training the back, abdominal, upper leg, gluteal and side muscles. To play the game, users have to lean to the left or the right while sitting or standing up to choose the right puzzle pieces shown on the sides and above the illustration in order to put it in the spot highlighted in white. Therefore, different motives have been chosen to make the game optically appealing. In regards to the different motives and single puzzle pieces, which can be hard to identify as the correct ones, no time limit is set to solve the puzzle.

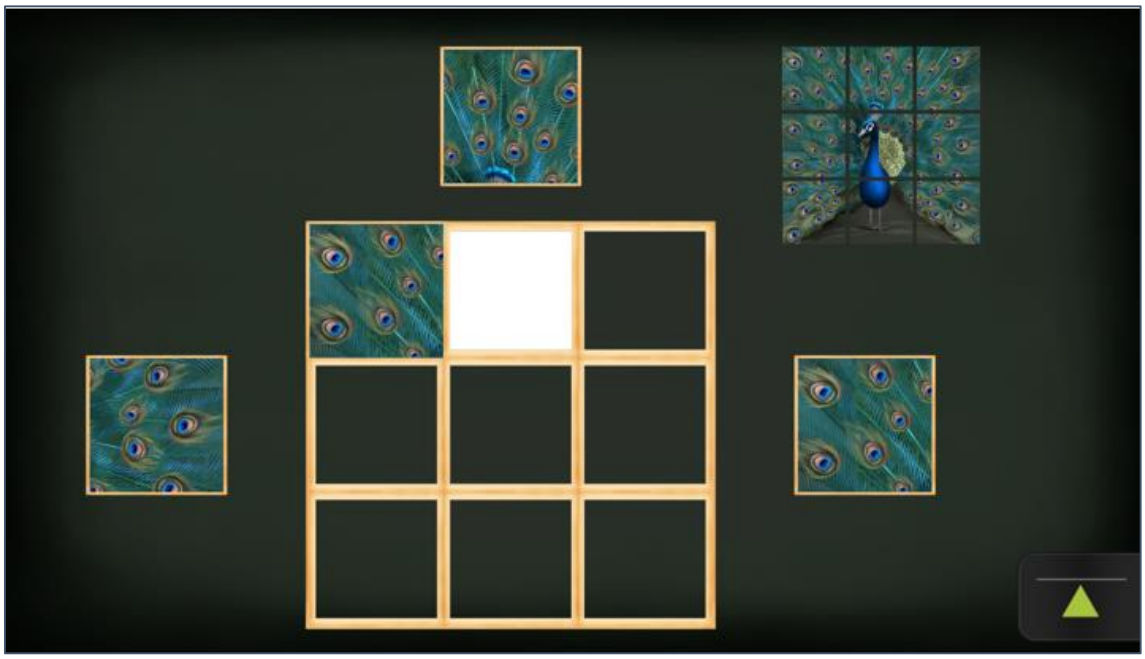

Figure 12: Puzzle Game

Some participants pointed out the size of the puzzle. It was explained that the pictures are often too bright and/or too small so they are not able to tell single pieces apart.

*“Especially by playing the puzzle, I would just need my visual acuity actually.” (Participant, 75 yrs., female).*

Other crucial feedback reported by participants regarded sensor problems. Occasionally, puzzle pieces were moved automatically although the participants did not move at all. Sometimes, pieces that were moved by the platform itself were coincidentally the right or wrong ones.

*“When I played last time the puzzle didn’t work, the camera did not see me when I stood up, the bingo worked but then the fox stopped working and there was no response when touching the screen so I have stopped the training.” (Participant, 74yrs., female)*

*"In the last few times, with the puzzle the system does not react when I stand up. Maybe it is because of the light, when I closed the windows, it got better." (Participant, 67yrs., female)*

Another issue that has not been considered enough is the moderate color blindness of some test users. This often made it difficult to differentiate between two similar puzzle pieces.

*„There are little things, for example, a piece of heaven down the right corner or a small black spot. I cannot see in my situation" (Participant, 75yrs., female)*

People perceived the puzzle game as quite difficult and challenging. One of the users mentioned in every interview that she underestimated the game and could not solve every puzzle:

*"I have to say honestly, in the puzzle, although I thought "pff" I will do this easily, I was very disappointed and I cannot even do it today completely. This is really difficult, there are different colors. I always believe that I can finish it but I always get something wrong, at least three times" (Participant, 89yrs., female)*

Another participant mentioned that she thinks her puzzle skills improved throughout the study period.

*"I improved myself at the puzzle. I often chose the wrong piece, twice or sometimes even three times. That does not happen to me anymore." (Participant, 78yrs., female)*

## 5.2 Bingo

The bingo game trained the muscles in the pelvic-area as well as the thighs. In this game, the focus lies on trying to stand up from a sitting position, thereby improving velocity.

While playing, the display showed a bingo card with various numbers next to a bingo ball with one number written on it. The aim of this game is to stand up from a sitting position, as soon as the number shown on the ball matches one of the numbers on the bingo card. By training to stand up, major improvements in gait velocity and standing up can be made and the user can stand up more easily the more this is practiced. The faster and easier the user is able to stand up and react to the number shown on the ball, the safer walking and standing up will be. For each ticked off number on the bingo card, the user receives one point.


Figure 13: Bingo Game

In general, most participants did not enjoy the Bingo game very much. The bingo game has shown a high number of sensor malfunctions, such as not recognizing the movements of participants. Therefore, the sensor did not react when people stood up for the number shown on the screen.

Additionally, participants perceived the bingo game as rather boring and too slow. It could be improved by showing more numbers on the bingo card and reducing breaks in between numbers, which are shown on the ball.

*"Bingo is boring." (Participant, 75yrs., male)*

*"At bingo, you only move up and down, there is the break when the number is not there, this break is too long, that could go a little faster from my point of view. "(Participant, 69yrs., female)*

Especially the bingo game showed striking sensor problems. The sensor often did not recognize when people stood up or sat down. Participants had to be creative and tried out various movements so the sensor would be able to recognize the movements correctly.

*"Bingo is very easy. Sometimes I have to stand for 6 times, and another 4 times and then I think that I am doing worse. I like playing the games, but I do not see what the purpose is of the game." (Participant, 74yrs., female)*

Furthermore, some participants reported, that the scores of the games were not comprehensible for them.

> *"Well, there is no logic at all in getting scores from the game. Take bingo for example, sometimes you can play it 5 times and sometimes you can play it 10 times and then you get some points, but there is no logic at all." (Participant, 74yrs., female)*

One participant claimed that she found a strategy to trick the platform while playing the game.

> *"The bingo betrays itself quite easily, if the number is not there, the music comes immediately. And when the music is there, you know: okay, - where is the number." (Participant, 69yrs., female)*

## 5.3 Arithmetic

The calculation game aims at strengthening both arm and shoulder muscles as well as improving mobility (of the upper body) in general. The calculations include additions, divisions and multiplications. The level of difficulty varies and a time limit of 30 seconds is set in the beginning of the game to give as many correct answers as fast as possible. This time limit can vary depending on the level of difficulty from 5 to 55 seconds.

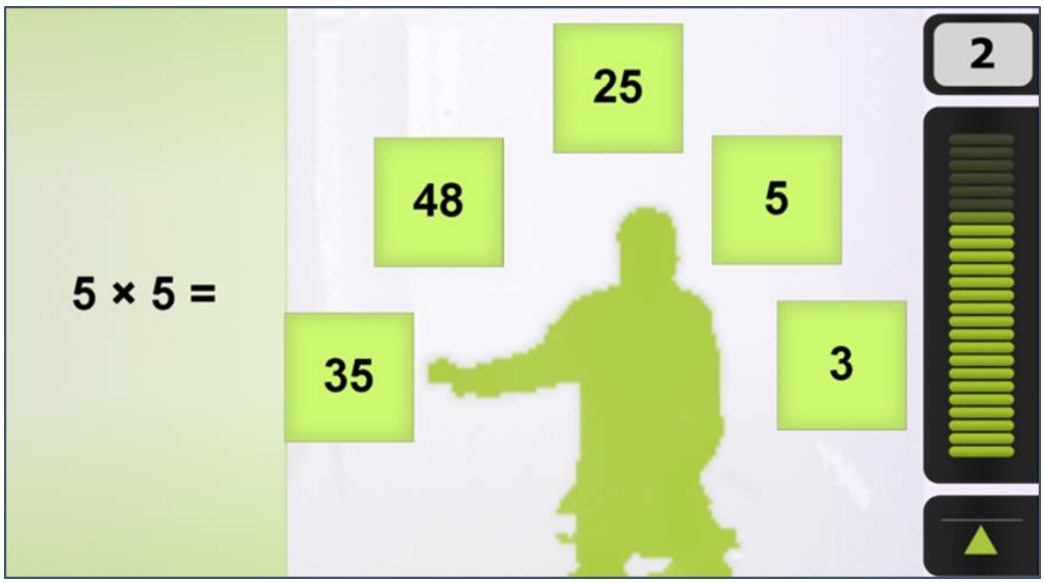


Figure 14: Arithmetic Game

Generally, most test users described the game as mentally challenging and fun. The game triggered emotions for especially those test users who were used to mental calculating due to their previous jobs. During interviews and focus group discussions in Vienna, some users reported that oftentimes one could cheat by simply calculating the last one or two numbers, however this would only work with less difficult calculations. Especially calculations where one had to multiply or divide, cheating was often not feasible. Our results from interviews and discussions during the focus groups stressed that many users were very ambitious not to make too many mistakes when playing the calculation game.

> *"Multiplying is a lot easier that is easy, but dividing, there my cells have to work quite hard, I have to admit, but that is also the point of the whole exercise." (Participant, 69 yrs., female)*

Some reported that the calculations were too easy and did not become more difficult which has been reported with other games as well. During the testing period some test users reported that after a while they had three possible answers instead of two (in the beginning), thus they also had to get up in addition to moving the left and right arm to the side. Some suggestions for improving the game, i.e. making it more difficult mentioned by participants during the focus group discussions were to set a time limit for how long the possible answers were shown and to include more difficult calculations, for instance extracting a root.

In line with other games, some test users faced problems due to the sensor, when the sensor did not capture the arm movements. Some test users reported that they bended a lot but the sensor did not recognize the movement, thus some people thought in the beginning that their answer was incorrect, as the game did not react to their movements.

> *"Only when calculating, when it doesn't react, I think I have calculated it wrong, I don't do anything (…) then I try again, I have to move out more, there is something I'm not doing correctly with the arm movement." (Participant, 78yrs., female)*

## 5.4 Fox and Grapes

The fox game aims at strengthening the upper body, specifically the core/abdominal and lower back area. Slightly different to the puzzle game, the fox game aims to stabilize the upper body muscularity and the vertebral column by leaning to the left and right. In this game, the user represents the fox and has to either catch berries or avoid branches falling from the sky. The game can be set in different levels of difficulty, in which the speed of the items falling from the sky and the range of motion having to be used by the player to catch or avoid falling items can vary.


Figure 15: Fox Game

Throughout the field trial test users, also those who were very fit and active, described the fox as a challenging and fun game.

> *"A favorite part so to say is the Fox, I really really like it, with catching the roasted chicken." (Participant, 75 yrs., female)*

The fox game was also discussed as a game where one clearly improves over time (similar to the Axolotl game) as one better understands how to move the Fox, how to jump and how to avoid the falling branches.

*"You have to learn with the fox game and the branch, at what point it doesn't matter when you touch the branch I remember at the first or second time I have touched it [the falling branch] too early, (…) you have to adjust to the games I would say." (Participant, 75 yrs., female)*

One participant for whom the fox game was not physically challenging enough came up with his own strategy to make the game more challenging. He used a swivel armchair in order to make the game more difficult for him as the chair moved whenever he leaned the left or right side in order to catch the grapes. In comparison to other games the design of this game and the fox especially was mentioned relatively often by users. Many thought that the fox was cute looking.

*„The fox, I really love him, he is so cute, I have to take care that I don't constantly look at the fox all the time." (Participant, 75yrs., female)*

Some reported problems with the sensor, but considerably less than within other games (e.g. Calculation Game).

## 5.5 Axolotl (Deep Sea Diver)

To execute the Axolotl game, a stretchable resistance or gymnastics band is used, depending on the users' strength. The aim of this game is to strengthen arms and shoulders as well as the upper back muscles to support an upright posture.

The intention of the game is to collect as many shells as possible, each collected shell being the equivalent of one point for the overall score at the end of the session. By stretching the band, the axolotl swims higher on the display to collect shells, whereas when the gymnastics band is let loose, the axolotl lets itself sink to collect shells nearer to the ground. Therefore, what's of importance is that the band is stretched in the proper way to make sure no injuries occur.

Regarding this, the band is supposed to be stretched in front and a little above the head to shoulder width, so that not only the sensor can recognize the band respectively the movement, but also to stimulate the designated muscles for the exercise and prevent any injury.


Figure 16: Axolotl Game

The field trial showed that the majority of participants had troubles executing the right movements to manoeuver the deep-sea diver towards the shells in order to score. Participants reported that the diver often would not swim towards upper or lower shells:

*"Sometimes the deep sea diver does not work, it does not want to dive upwards or downwards."* (Participant, 69 yrs., female)

This can have two reasons. First, the movements, which are captured by the sensor need to be executed in a specific manner to guarantee the proper functioning of the motion sensor. Doing these movements under pressure (the time limit of the game) can lead to doing the exercise improperly. Thus, the sensor of the game could have had problems finding out the actual position of the theraband and arms.

Second, as reported by physiotherapists, especially this game is prone to problems regarding the sensor. The sensor is stuck from time to time and the gaming session needs to be started again in order to be able to continue with the other games. Users managed to solve the problems themselves by turning the system off and on again or by pressing the skip-button in the upper left corner of the screen.

*„It does not always work properly. Specifically the deep sea diver, especially this does not work properly. Sometimes, when I pull [the theraband], it does not swim upwards, it stays in the middle and when it is supposed to swim downwards, it just skips the shells." (Participant, 72 yrs., male)*

Nevertheless, the design and appearance of the deep sea diver was perceived as rather cute. Participants liked to play the game regardless of the sensor problems:

*"My favourite game is the deep sea diver because I love it when it looks at me." (Participant, 70 yrs., female)*

## 5.6 The Mole

The mole game aims at improving balance and coordination while walking and is one of the more physically challenging games provided by the platform. The user stands on a 1x1m²-field divided in nine spots. Each time a mole appears in one of the nine spots, the participant has to step on it so it disappears again. Each mole that is being stepped on counts as one point.

Additionally, the level of difficulty can be modified by implementing mice running over the field, which are also meant to be stepped on by the player. Furthermore, ladybugs, who appear from time to time, however should not be stepped on. Each time a ladybug touches the player, they lose two points. If these tasks are still too easy, the field in which the user moves can be expanded to 2,25m² (if room allows).

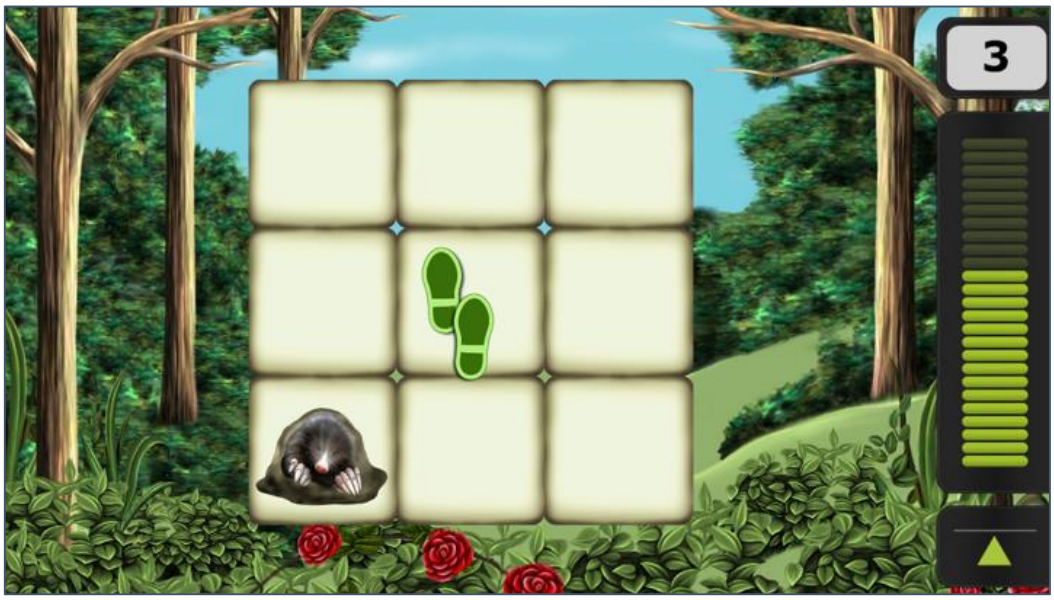


Figure 17: Mole Game

Analysis of the user interviews showed clearly that generally this game is rather exhausting. In their narratives, users stressed that they needed to catch their breath from time to time while playing.

*„This jumping in the mole game, it does make me puff and blow.“ (Participant, 75 yrs., female)*

The mole game, which fitter participants enjoyed more than the less fit, increased in difficulty in the user's perceptions especially when the field expanded. Users explained that after they had reached a more difficult level and thus a bigger field, they had to take not only one, but up to three steps in order to step on the mole while keeping balance. In combination with the time limit set by the game (shown in Figure 17 on the right) participants enjoyed being challenged by the system and felt that they made improvements in keeping their balance.

In accordance with one participant who pointed out that this game might be too difficult to play for very old players, because some might have a hard time keeping balance even while standing, another participant complained that the field was too big for him, even though he did not have difficulties keeping his balance:

*„Sometimes it [the field] is too big, it just does not work out.“* (Participant, 72 yrs., male)

Due to the expanding field, one disadvantage of the varying levels of difficulty was seen in the lack of space many participants had in their apartments, which made it hard to not hit or step on something when walking backwards. This made it even more difficult to play, when the game was already set on a high level. Users experienced sensor difficulties as oftentimes the sensor saw movements where no movements were enacted, making it harder for players to avoid touching ladybugs and stepping on moles.

All in all, users were happy to find ways to outsmart the sensor by not actually stepping in one direction but only lifting their foot so the sensor would detect their movement as a step that has been made. However, this trick only worked for people who were very good at keeping their balance.

## 5.7 Gardening

The gardening game aims at strengthening the legs by bending the knees up and down. Players have to move the shovel by taking steps to the front, left or right, and digging up the vegetables in the garden by bending their knees. The gardening game was added halfway through the second trial phase.


Figure 18: Gardening Game

Most of the participants accepted the new gardening game and integrated it in their playing routine. Many of them described the game as physically challenging and fun, most participants stressed that the gardening game was a funny alternation to the other games, which they had already been playing for about 5 months. Most of the participants did not report any technical problems, but the challenging knee bending that they faced at the beginning of their playing surprised them. One participant for instance mentioned that the game encouraged them to boost their performance in further playing sessions of the gardening game. Statements like these and their openness towards the gardening game stressed that this new game addition was very important and valuable to keep test users motivated to play and engaged. In addition, another participant emphasized that this game might strengthen physical functionalities as after playing it participants would feel an increase in their activity:

*„I guess if someone is physical restricted in some way, then it is probably a good workout.“* (Participant, 69 yrs., male)

## 5.8 Personal Scores

After the first half of the second field trial the software of the EnterTrain platform was updated allowing users to view the score they have achieved throughout their playing sessions in each game. This new function was added to the start screen and can be viewed before or after each gaming session.

When participants were asked about how they perceived this change, their answers were quite diverse. A few users felt indifferent about the new feature and used it to take a quick glance at their results from time to time. Others, who used to write their own "gaming diary", welcomed the update since it was a good alternative to writing down their scores on a sheet of paper after each game:

> *"Yes in my opinion it is not bad because earlier I used to write down the scores myself. But now I save my troubles, although sometimes it is questionable for me because I think I wasn't that good but then the game instructor says it was nearly the best score I have achieved yet." (Participant, 69 yrs., male)*

A strong focus during the interviews lied on how the scores were calculated. Participants were often confused about how their score was calculated. Thus, a better explanation at the beginning of each game could ensure a better understanding of the scoring system. Soon, users started to create their own theories about how to achieve a higher score. One user for instance reported:

*"I like playing the games, but I do not see what the purpose is of the game. […] Do I have to be quick? Or is it the movement that is important? It would be nice to have an explanation on the purpose of the game. Because then I also know what the scores indicate."* (Participant, 75 yrs., female)


Figure 19: Statistics of the Results visible to players

Apart from this concern, participants explained that the visualization of the total score could be changed. The new feature showed a list of scores for each game in each gaming session, starting with the first ever saved score. This was perceived as a little annoying, although most of the people did not mind it too much. In general, participants were happy about the new feature of the platform, even though it would be an advantage for them to show the scores of the last session first.

Participants who used the score lists regularly perceived the possibility to look up their scores as highly motivating in order to keep playing the games or becoming even better. Because of this, one participant even said it encourages him to increase the level of difficulty due to his curiosity and willingness to manage a more difficult level. Hence, generally it encouraged users who tended to be competitive to set new goals and to attain them.

## 5.9 Sensor Problems

Throughout the test phase, users reported of various challenges regarding the motion sensor attached to the screen (of the gaming platform). In general, the functioning of the sensor varied from person to person, functioning without any troubles in some households and showing regular issues in other households. Participants usually mentioned problems with the sensors when mentioning specific games and situations and then explained how they tried to solve the problem. What has been discussed during the interviews can be summarized in two main aspects:

The motion sensor does not react to movements of test users

What has been widely discussed and confirmed by technicians and physiotherapists, is that the motion sensor failed to perceive any motions in a few households when playing the arithmetic game. Thus, the arithmetic game had to be taken out of the system for some test users for some time to be installed again in an update. This problem only occurred in certain households, even though the exact reason for this has not been explored yet. Users were competent in solving the issue themselves for the moment by resetting the game or pressing the cross on the upper left corner of the screen to skip the game and thus continued playing the next game, which usually worked fine. Users also tended to wait for something to happen, which also helped the system to recover by itself in certain cases.

In regards to the puzzle game the sensor only caused problems at a higher level of difficulty. At the most difficult level in which three pieces to choose from are placed on the left and right-hand side and above the puzzle have to be chosen in order to complete the full puzzle. The sensor did not always capture the piece above the puzzle, even though the right movement was enacted. Again, participants were creative in trying to solve the problem themselves and, instead of raising their arms, stood up so the sensor would realize the movement. This usually helped and the game was continued.

Participants encountered sensor issues with the deep-sea diver game too. The deep-sea diver, which is supposed to catch shells on the ground of the sea and right underneath the surface of the sea by users expanding the exercise band and loosening it again, did not move towards any of both directions. Instead, it swam right in the middle, catching no shells at all, even though users enacted the movements according to the games' rules. This might have to do with the test round, in which users need to expand the exercise band four times to help the sensor adjust to the width of expansion that will be performed by users later. Users, who stretch their arms out as far as they can in the test round can have difficulties moving the deep-sea diver towards either the bottom or the top of the screen, potentially missing shells and thus achieving lower scores. In contrast to the non-reaction of the sensor, this problem could be solved very easily after the consultation of a technician or physiotherapist.

The mole game has shown that the sensor needs to be more precise when it comes to capturing movements of the participants. Not only was the mole game perceived as exhausting by many test users, but some participants were annoyed as they received lower scores due to the malfunctioning of the sensor. Participants reported that the sensor mistook even the smallest movements of participants as big steps. Even standing still was interpreted as a significant movement by the sensor, which made it quite difficult to avoid ladybugs in the game:

*„while playing 'the mole', I am standing still but the feet are fidgeting on the screen."*
*(Participant, 75 yrs., female)*

Another aspect that was mentioned by the test users was the sensor's delay in reaction when playing the mole game. This lead to lower scores even though users did nothing wrong.

The motion sensor does not identify players

The motion sensor had difficulties recognizing players from time to time. Even though the sensor instructs users to sit or stand in a certain spot and displays this spot on the screen, when users actually got into the right position, the sensor was still not able to detect them. Users tried to solve this problem on their own by moving their chair, resetting the platform or skipping the whole game to continue with the next one. Participants also tried standing up so the sensor could see them more easily. This often helped. One explanation for this issue is that the sensor needs enough lighting to work properly, as is also confirmed by technicians. Users solved this problem by turning on the light every time they used the platform. Another explanation might be the adjustment of the sensor itself, if it is adjusted a few degrees too high or too low it is not able to cover specific areas important for the game, e.g. the mole game, in which the floor needs to be covered to a certain extent.

## 5.10 Main improvements in test phase 2

Some functions and features were already implemented before the second trial phase, which started in May/June 2018. Main improvements to the gaming platform included:

- An additional question for users after each game whether the level of difficulty should be increased for a game.
- A new function enabling physiotherapists to add, edit and change user capabilities in regards to the games that users are able to play due to their physical capabilities, i.e. abduction range of left or right arm.

The main update of the gaming platform took place after the first 3 to 4 months of the second trial phase. This update was installed for the test users in October 2018, which was halfway through the trial phase for most participants.

- In order to have more variety a new game was installed. The gardening game trained strength in participants' legs and knees, by bending down in order to harvest vegetables. The new game was very much appreciated by most test users.
- A new function was added enabling users to skip the tutorials (and explanation texts) in the beginning of each game by simply touching the screen anywhere twice in a row. Thus the users decided themselves how often and if the explanations are shown.
- A pause button was included to give the users more freedom while playing, as users have complained about not having the possibility to pause the game, if they were interrupted by a telephone call or the users needed to go to the bathroom.
- The sensor configurations were re-adjusted, as test users reported that especially during some games (e.g. Bingo or Mole game) the sensor did not capture them well (see 5.9).
- A results button was added which appears on the start screen where test users can look at their daily scores on a timeline for each game.

# 6 Mobility Assessments

During the field pilot, there were three main methods to assess measure the participants' fitness. The assessment methods are shown in Figure 10. The first method includes the separately installed 3D sensor at the participants' site with integrated Tracking System measured movement within its field of view over the whole pilot duration. It was primarily used to adapt the gaming settings according to the fitness trend of the last 3-days, but it provides a useful insight in the change of the participants' health change over time. The second method consisted of regular Assessment Tests conducted by a physical therapist. The physiotherapist measured the conducted test manually using a Stop Watch (SW). Additionally, the tests were recorded using 3D-sensors. The recordings were manually annotated by a human, i.e. the recorded sequence is watched frame by frame and the respective frame where a test begins/ends is manually labeled. Since this is the most accurate method, it is used as ground truth for comparison with the other techniques. The recorded sequence is also used for automatic tracking using the same tracking algorithm as in the long-term system (installed at the participants' sites). Hence, it was possible to directly compare the tracking algorithm performance to the manual annotation and the physiotherapist's measurement. The third method to assess the performance was the Gaming Platform. This was mainly used for immediate difficulty change based on the users' performance, but also the results are compared to the tracking and assessment tests

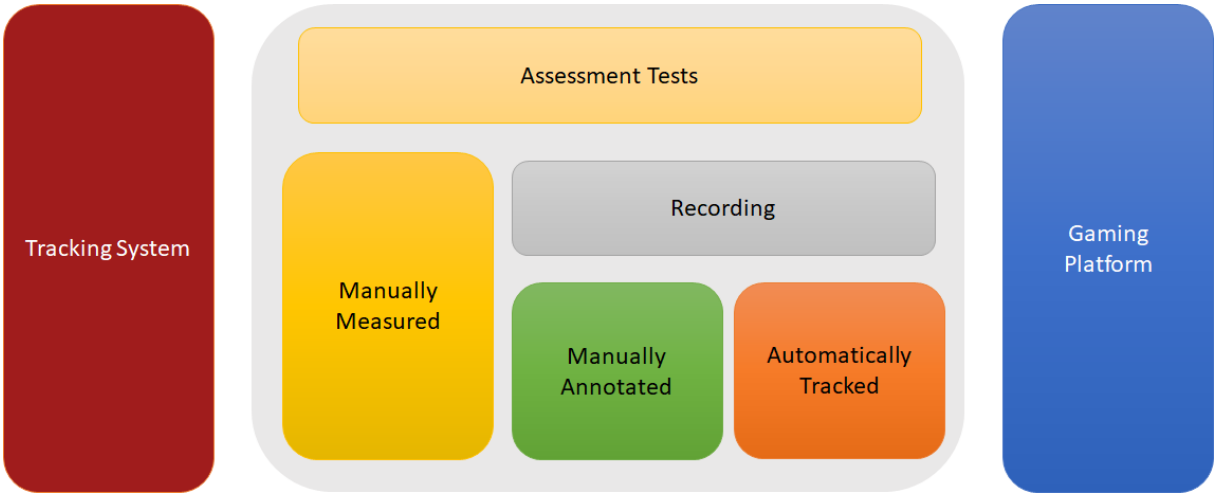


Figure 20: Assessments overview during field pilot

## 6.1 Physiotherapists

During the installation of the exergaming platform in Netherlands and in Austria physiotherapists assessed the health status and physical functionalities of all test users in order to set the appropriate game settings. The mobility assessments repeated three times during the trial phase in order to screen possible change in regards to the mobility of test users. The assessment by physiotherapists included standardized tests, like Single sit to stand, Timed up and Go (TUG, Figure 21), Short Physical Performance Battery (SPPB), Gait speed 3 meter and Chair stand test.

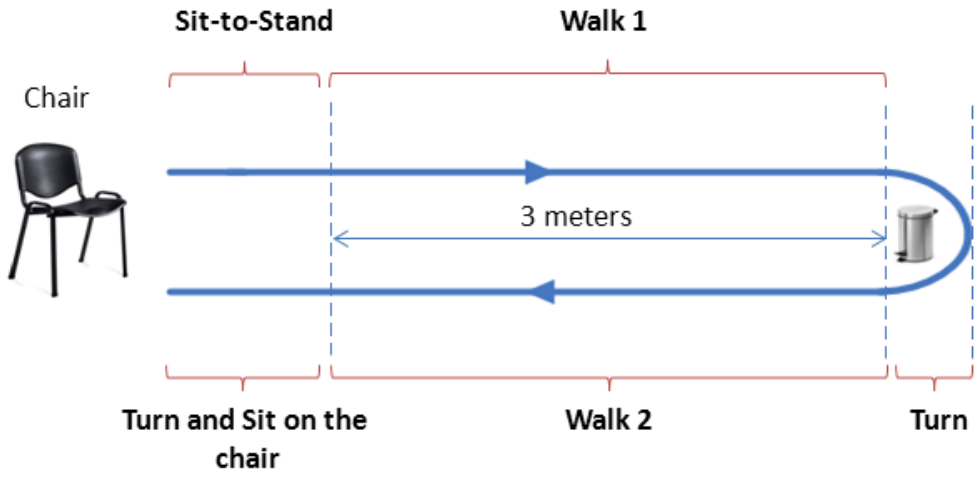


Figure 21: Timed Up and Go (TUG) test: Person stands up, walks 3m, turns around, walks back and sits down again

### 6.1.1 Perspectives of Physiotherapists

Both physiotherapists in Vienna and the Netherlands reported that participants generally trusted them, which allowed them to get a lot of information about their medical background. This is important to know given that the physical activities of the participants varied a lot depending on their activities in daily life. Moreover, the physiotherapists emphasized that with their support and expertise they were able to suit the systems well for the abilities of the clients. Sometimes the physical abilities of test users changed throughout the test phase due to falls etc. Therefore, physiotherapists played an important role especially in regards to analyzing data from the movement tracker as well as from their mobility assessment tests and observations. Hence, they were able to trace an increase or decrease in the participants' play behavior and to set the gaming settings accordingly. Both physiotherapists stressed that because of their experience with older clients they have "a certain awareness for the smaller things" (Lydia, physiotherapist, the Netherlands), meaning the awareness to recognize restrictions e.g. of the range of motions some test users had. In addition, they suggested that getting information about the participants' progress on a regular basis would have a motivating and enriching impact on test users. When asked about possible clientele and field of application both physiotherapists suggested the use of the exergaming platform in hospitals since there are clients already experiencing a certain health decrease that could be changed with the help of the EnterTrain system. Concluding, the physiotherapists saw themselves as important actors for a successful gaming experience since many test users felt safer being supervised by professionals.

### 6.1.2 Physiotherapists' Measurement

The assessment tests conducted by the physiotherapists were recorded using 3D sensors. All recorded sequences were manually annotated by a human. Figure 22 shows the annotation tool used for labelling all tests. From the start/end of each test the respective duration and additionally the velocities can be derived, since the walking paths' length is fixed.

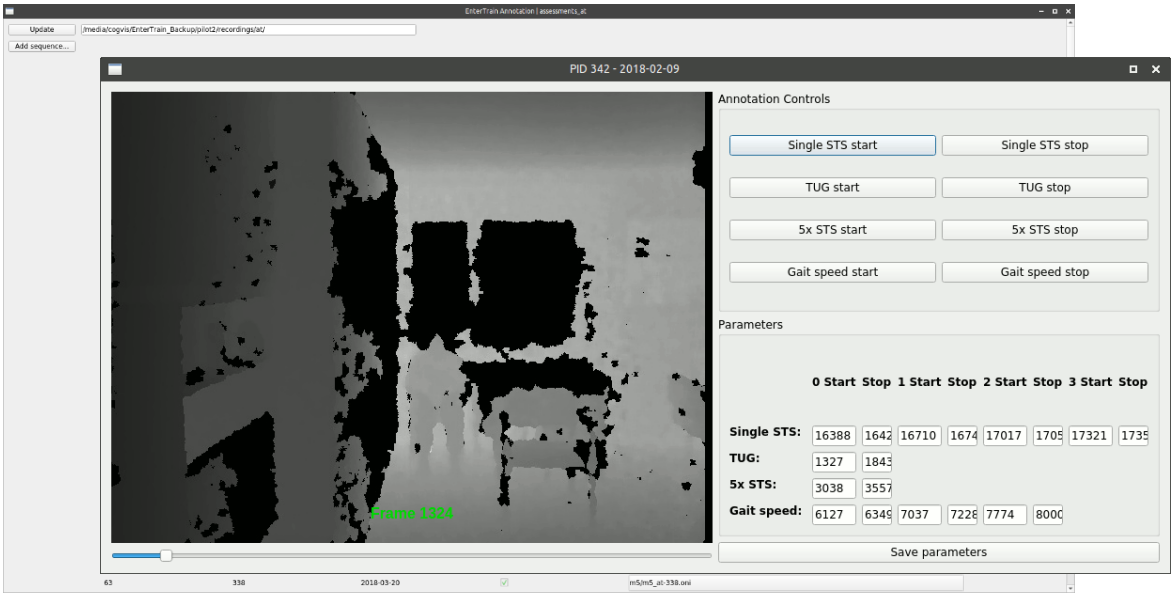


Figure 22: Annotation tool: a person needs to go through every sequence frame by frame to label start/end of a each test

The annotations are compared to the stop watch measurements of the physiotherapists. Figure 23 shows the average error of the physiotherapists. It can be seen, that the respective deviation varies depending on the physiotherapist. The average deviation is 1.055s.

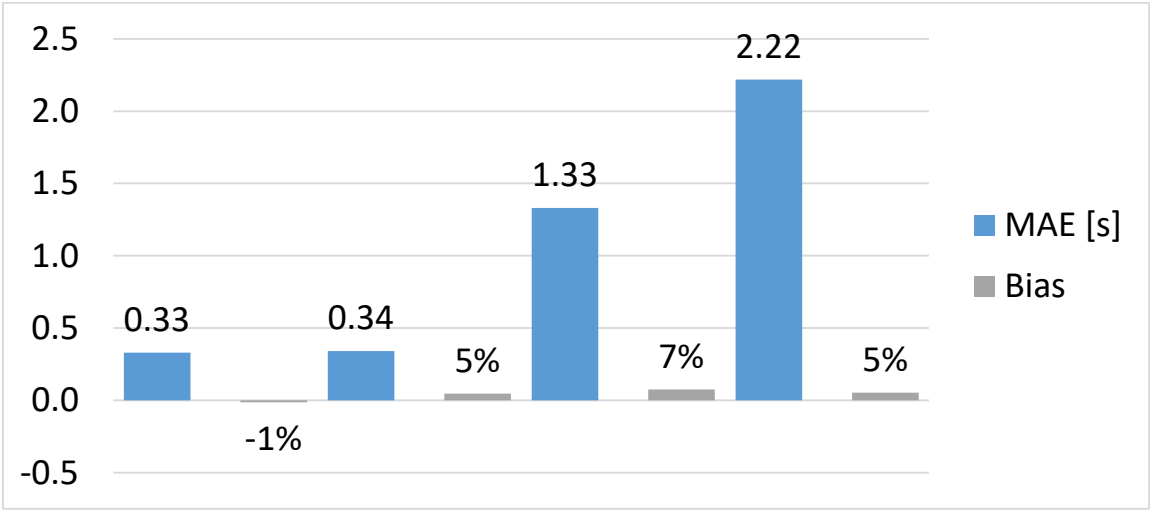


Figure 23: Mean Average Error (MAE) and Bias of Physiotherapists

The mainly positive bias shows that human timing takes longer than the actual value, which results from the reaction time of the physiotherapist and the test person.

## 6.2 Automated tracking

The recorded sequences where used for automatic tracking in order to compare the tracking algorithms directly to physiotherapists' measurement and manual annotation. Figure 24 depicts the relations between a recorded sequence, the annotation and the actually extracted data. In the **sequence** all tests are recorded. The **annotation** labels the respective starting and end point. The tracking algorithm detects where a person is moving within the recorded sequence, resulting in person **tracks**. The person tracks are then analyzed by another algorithm for certain movement patterns such as **walks**. These movement patterns are then further analyzed for containing features such as walking velocity, distance, duration, etc.

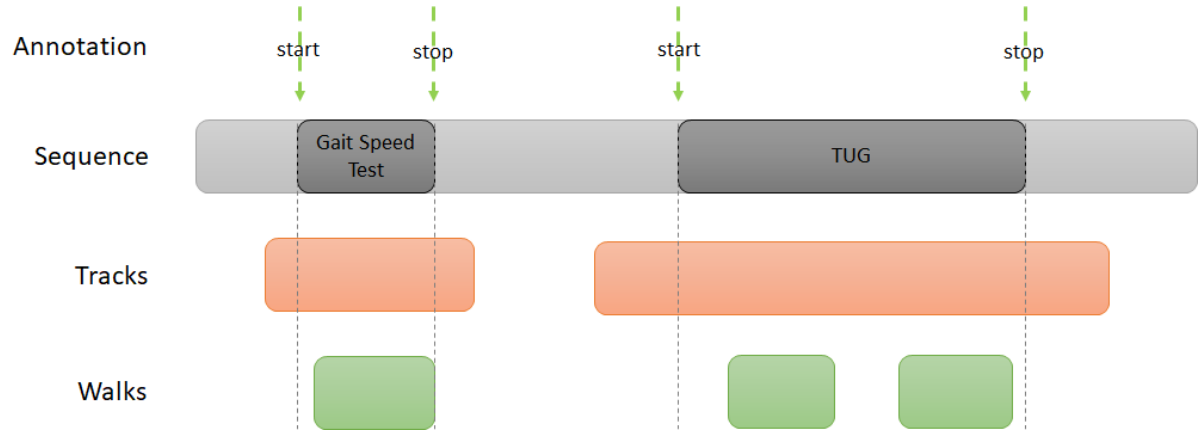


Figure 24: Relations between Sequence, Tracks, and Walks

Unfortunately, the data recorded in the Dutch pilot are incomplete due to a high number of drop-outs and hence participant fluctuation, and can therefore not been used for the annotation-tracking comparison. However, the Austrian data show following result. There is a positive correlation of 0.68 between the annotated test and the tracked walk with a mean absolute error of 0.153m/s. The limitation of this test are the different apartments of the persons, which were partly narrow, which resulted in some walks not being completely recorded. However, it was very important, that the participants could carry out the tests in their own homes to keep the effect of the test situation and the stress to a minimum. Table 1 shows the comparison between the manual annotation and the automated tracking during the gait speed test. The comparison is illustrated in Figure 25.

Table 1: Comparison of Gait Speed (GS) test: results of manual annotation and automatic tracking

| | GS annotated [m/s] | GS tracked [m/s] | diff. abs. | MAD | COR |
|---|---|---|---|---|---|
| **Mean** | 0,754 | 0,852 | 0,098 | 0,153 | 0,680 |
| **STD** | 0,187 | 0,222 | 0,035 | | |

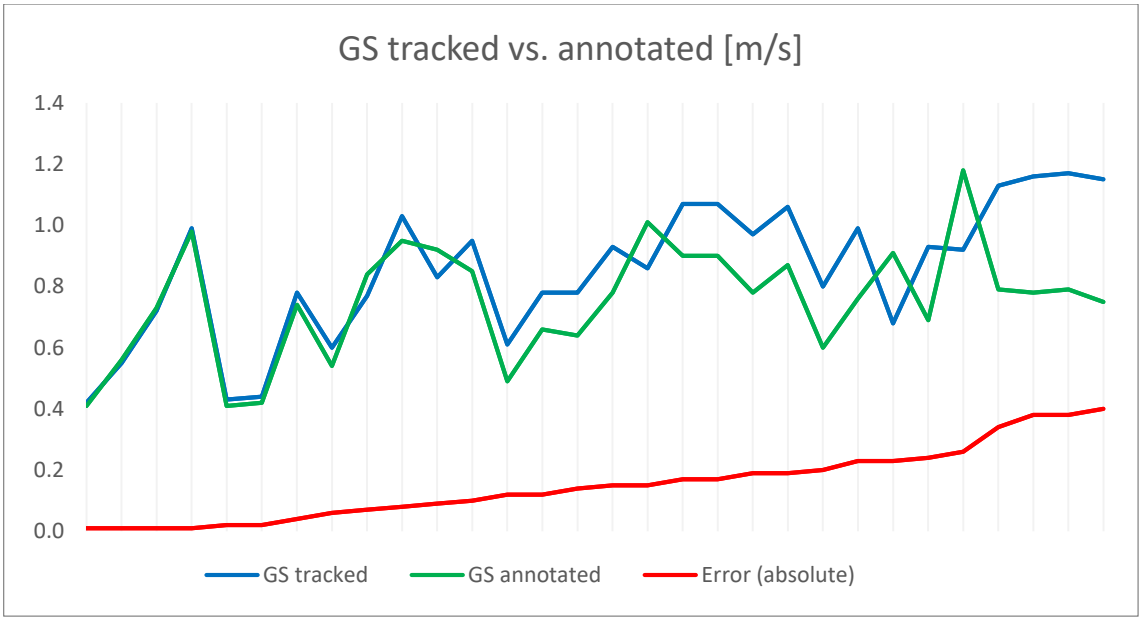


Figure 25: Comparison between manually annotated and automatically tracked Gait Speed (GS) test and their Mean Absolute Error

## 6.3 Influence Gaming Platform

For analysis of the Gaming Platform influence, the Austrian participants were divided into two groups:

- Group 1: infrequently played, i.e. <= 10 times per month (considered as workout)
- Group 2: frequently played, i.e. > 10 times per month

The physical status of both groups is depicted in Figure 26 showing the status at the beginning and in Figure 27 showing the status at the end of the pilot phase. In can be seen, that the infrequent players were fitter already at the beginning. This means, that the system is more often used by persons how are less fit. Additionally, it can be seen that the frequent players improved a lot and in the end had a similar physical condition as the other group.

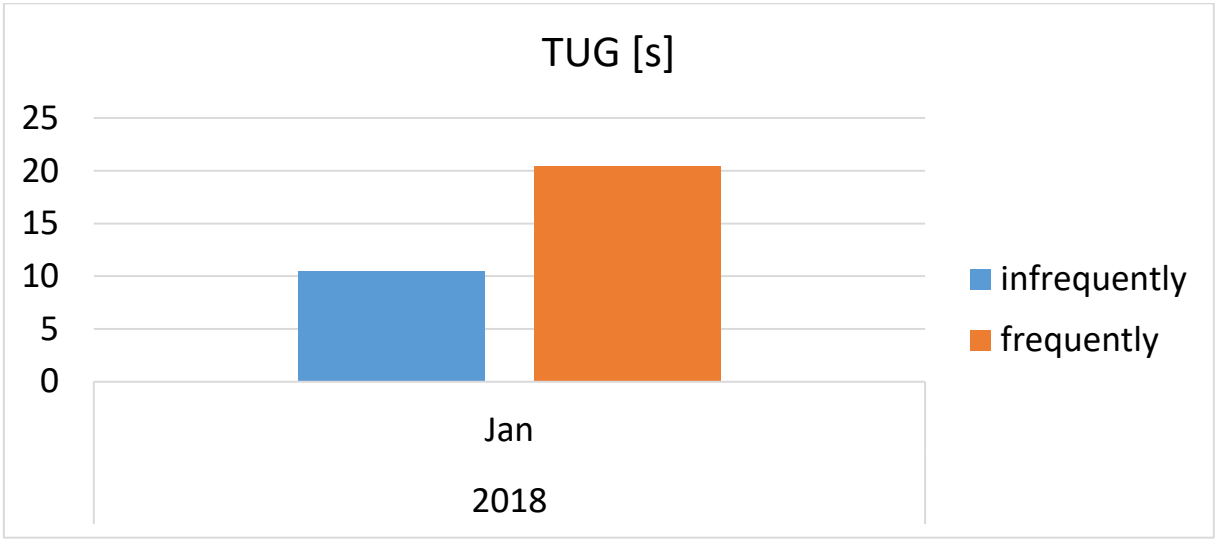


Figure 26: Participant groups at the beginning of the trial

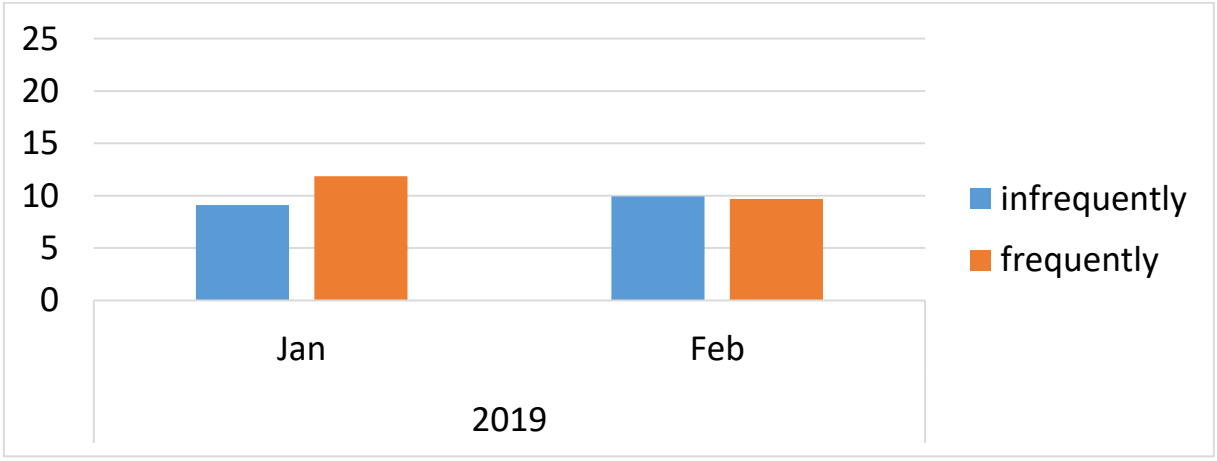


Figure 27: Participant groups at the end of the trial

Figure 28 shows the course of the two groups over the duration of the pilot phase measured using the Timed Up and Go (TUG) test. It clearly shows the improvement of the frequent player group and the impact of the Gaming Platform after installation. It is interesting, that the Gaming Platform has the most impact in the first two months after installation. This is due to the fact that the system is the more frequently used at the beginning and that the improvement is physically limited, which is illustrated by the fact that the fitness levels of the two groups converge. Since the improvement is strongest at the beginning, use over a longer period of time is likely to become less interesting. This also correlates with the statements in the interviews, where people said that the games were more interesting at the beginning, although the games were modified and a new one added.

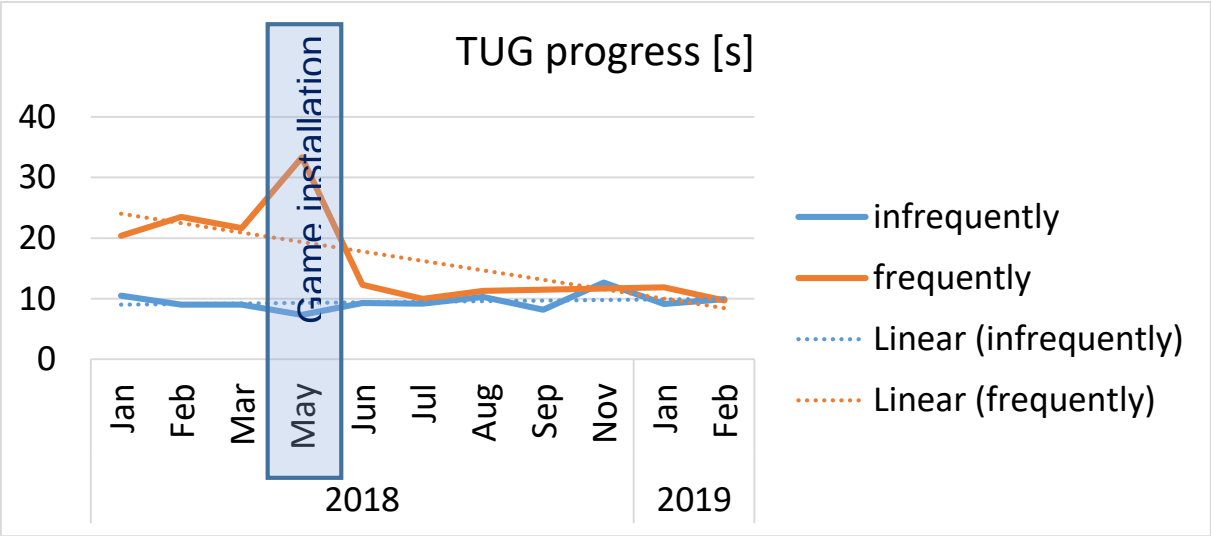


Figure 28: Participant groups' fitness progress over the course of the pilot

## 6.4 Evaluation of Measurement Results

### 6.4.1 Austria

**Methodology and Data**

Velocity and Timed Up and Go (TUG) test measurement data of 17 individuals, partaking in the Austrian experiment, is used for this evaluation. Data was collected between January 2018 and February 2019. The time stamps $t0$-$t5$, given by Table 2, correspond to TUG average measurements, which were conducted six times throughout the experiment. However, as given by Table 2 (b), not all individuals (see id 353-358) did partake in every TUG. Consequently, less than five data points are available for these individuals. Time stamps $t0$-$t4$ correspond to the months of January, February, May and August 2018 and $t5$ to the month of February 2019. The exact date of measurement can vary between individuals, however. Velocity data was recorded on an individual basis, using automatic methods from the field of computer vision, resulting in multiple measurements per day throughout the duration of the experiment. To get velocity data points, representative of an individual's abilities at a given time stamp, the velocity was averaged within the time intervals $(t < t0, t0]$, $(t0, t1]$, $(t1, t2]$, $(t2, t3]$ and $(t4, t5]$. The resulting data set consists of tuples of velocity average and TUG average, at a given point in time.

Table 2: (a) Velocity average of 17 individuals, partaking in the Austrian experiment, measured at time stamps t0-t5 and (b) the corresponding Timed Up and Go (TUG) test average.

| (a) Velocity Average [m/s] | | | | | | |
|---|---|---|---|---|---|---|
| **id** | **t0** | **t1** | **t2** | **t3** | **t4** | **t5** |
| **332** | 0.56 | 0.55 | 0.56 | 0.54 | 0.55 | |
| **335** | 0.51 | 0.52 | 0.50 | 0.52 | 0.47 | 0.51 |
| **338** | 0.67 | 0.70 | 0.74 | 0.72 | 0.74 | 0.74 |
| **340** | 0.40 | 0.40 | 0.40 | 0.40 | 0.41 | 0.41 |
| **342** | 0.38 | 0.37 | 0.35 | 0.36 | 0.37 | 0.36 |
| **345** | 0.45 | 0.43 | 0.43 | 0.42 | 0.41 | 0.43 |
| **347** | 0.71 | 0.71 | 0.71 | 0.74 | 0.73 | 0.65 |
| **348** | 0.73 | 0.72 | 0.71 | 0.79 | 0.80 | 0.72 |
| **349** | 0.80 | 0.80 | 0.80 | 0.84 | 0.82 | 0.85 |
| **350** | 0.55 | 0.54 | 0.54 | 0.54 | 0.54 | 0.54 |
| **351** | 0.64 | 0.61 | 0.60 | 0.59 | 0.61 | |
| **353** | 0.53 | 0.51 | | | | |
| **354** | 0.47 | 0.59 | | | | |
| **355** | 0.45 | 0.46 | | | | |
| **356** | 0.57 | 0.53 | | | | |
| **357** | 0.50 | 0.48 | | | | |
| **358** | 0.44 | 0.46 | | | | |

| (b) TUG Average [s] | | | | | | |
|---|---|---|---|---|---|---|
| **id** | **t0** | **t1** | **t2** | **t3** | **t4** | **t5** |
| **332** | 8.97 | 7.08 | 6.81 | 8.54 | 6.38 | |
| **335** | 14.69 | 11.34 | 10.15 | 10.84 | 11.65 | 9.55 |
| **338** | 7.59 | 7.59 | 7.54 | 7.57 | 6.63 | 7.94 |
| **340** | 17.11 | 13.45 | 14.90 | 15.96 | 13.98 | 14.38 |
| **342** | 18.88 | 17.97 | 19.26 | 17.21 | 17.37 | 13.37 |
| **345** | 13.35 | 12.09 | 14.21 | 13.84 | 11.64 | 14.10 |
| **347** | 9.91 | 7.14 | 7.44 | 7.13 | 8.18 | 7.61 |
| **348** | 9.97 | 8.30 | 9.83 | 8.33 | 8.98 | 9.35 |
| **349** | 8.09 | 7.97 | 7.60 | 7.48 | 7.97 | 6.97 |
| **350** | 12.17 | 11.49 | 11.15 | 10.77 | 10.93 | 12.07 |
| **351** | 9.44 | 8.59 | 8.71 | 8.33 | 9.27 | |
| **353** | 9.99 | 9.65 | | | | |
| **354** | 9.16 | 8.28 | | | | |
| **355** | 9.52 | 8.37 | | | | |
| **356** | 15.27 | 10.83 | | | | |
| **357** | 7.18 | 7.68 | | | | |
| **358** | 12.64 | 12.17 | | | | |

**Evaluation Results**

Table 3 shows Velocity average and TUG average, averaged over all individuals at a given time stamp $t0$-$t5$. For simplicity, these values will be referred to as velocity average and TUG average respectively, from now on. Statistical measurements for the velocity average and TUG average such as variance, standard deviation, mean, median and the correlation coefficient (Pearson).

Table 3: Velocity average [m/s] and TUG average [s], time stamp of measurement

| | **t0** | **t1** | **t2** | **t3** | **t4** | **t5** | **VAR** | **STD** | **Mean** | **Med.** | **Corr** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Vel.** | 0.55 | 0.55 | 0.58 | 0.59 | 0.59 | 0.58 | 0.0003 | 0.016 | 0.572 | 0.578 | -0.249 |
| **TUG** | 11.41 | 10.00 | 10.69 | 10.55 | 10.27 | 10.59 | 0.2262 | 3.255 | 10.585 | 10.569 | |

Table 4 shows the Linear Regression t-Test for the relationship between the velocity average and the TUG average over time, showing that the assumed negative linear relationship is not significant at 5%.

Table 4: Linear t-Test

| **Linear Regression t-Test** | |
|---|---|
| 5% significance | |
| H0:= slope is not significantly non-zero<br>H1:= slope is significantly non-zero | |
| n | 5 |
| F | 0.2655 |
| P Value | 0.6355 |
| H0 cannot be rejected<br>Deviation from horizontal is **not significant at 5%**. | |

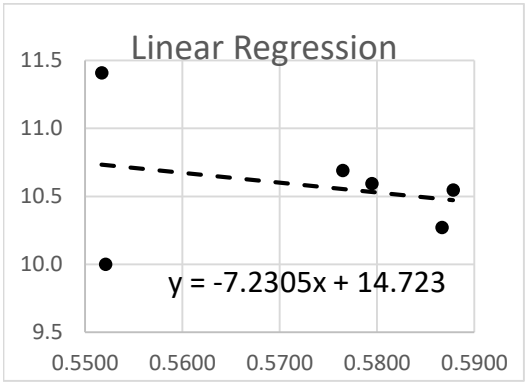


Figure 29 shows the correlation of velocity and TUG over time, showing a non-significant (5%) negative linear relationship with a correlation coefficient (Pearson) of -0.249.

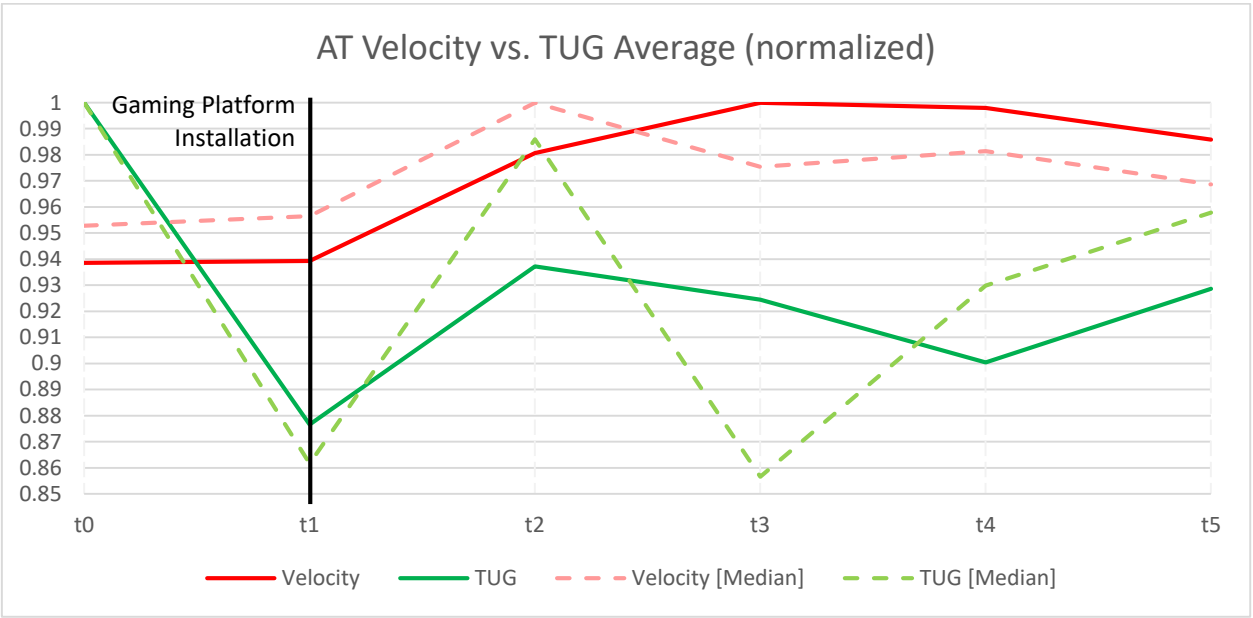


Figure 29: Velocity average (red), velocity mean (red dotted), TUG average (green) and TUG average mean (green dotted) over time

**Discussion**

Intuitively one would assume that there exists a negative correlation between the velocity of a person performing a TUG and the time it takes to complete the task. As a person becomes more and more agile through training, velocity should increase while completion time decreases. Figure 1 shows the progression of the participant group throughout the experiment. Time stamp $t0$ marks the installation of the gaming platform and it can be seen that the velocity increases gradually after this point in time, which indicates that mobility is indeed improved through training. The relative velocity increase amounts to 1.4 - 6.1%, averaging at 3.8% over time. The TUG on the other hand does not follow a clear trend as it oscillates over time. As given by Table 3, the correlation coefficient is -0.249, however, the linear regression t-Test at 5% significance (see Table 4) showed that the deviation from the horizontal is not significant. Therefore, the existence of a linear relationship between both variables is not supported by the underlying data. In fact, the relationship is of non-linear nature (see Section 6.4.3).

### 6.4.2 Netherlands

**Data**

Velocity and Timed Up and Go (TUG) test measurement data of 14 individuals, partaking in the Netherland experiment, is used for this evaluation. Data was collected between December 2017 and January 2019. The time stamps $t0$-$t3$, given by Table 5, correspond to TUG average measurements, which were conducted four times throughout the experiment. Time stamps $t0$-$t3$ correspond to the months of December 2017 (to February 2018), April, November 2018 and February 2019. When compared to the Austrian data set, it can be seen that not only less TUG measurements were taken, but also that the Netherland data is sparser, since many data points are missing. Of course, this is not an ideal starting point for an evaluation and it consequently weakens the significance of the results. The velocity average was computed as for the Austrian data set.

Table 5: (a) Velocity average of 14 individuals, partaking in the Netherland experiment, measured at time stamps t0-t3 and (b) the corresponding Timed Up and Go (TUG) test average.

| (a) Velocity Average [m/s] | | | | |
|---|---|---|---|---|
| **id** | **t0** | **t1** | **t2** | **t3** |
| **303** | 0.39 | 0.39 | 0.39 | 0.39 |
| **304** | 0.38 | | | |
| **305** | 0.51 | 0.52 | 0.50 | 0.50 |
| **307** | 0.45 | | | |
| **309** | 0.50 | 0.54 | 0.58 | |
| **310** | 0.62 | 0.57 | 0.57 | |
| **311** | 0.42 | 0.44 | 0.44 | |
| **312** | 0.65 | | | |
| **314** | 0.59 | 0.59 | 0.59 | |
| **315** | 0.62 | 0.63 | 0.63 | 0.61 |
| **316** | 0.63 | 0.63 | | |
| **317** | 0.52 | 0.53 | 0.55 | 0.52 |
| **320** | 0.42 | 0.44 | | |
| **322** | 0.66 | 0.67 | 0.64 | |

| (b) TUG Average [s] | | | | |
|---|---|---|---|---|
| **id** | **t0** | **t1** | **t2** | **t3** |
| **303** | 10.27 | 11.15 | 9.87 | 11.30 |
| **304** | 12.16 | | | |
| **305** | 10.44 | 9.49 | 12.63 | 10.15 |
| **307** | 11.16 | | | |
| **309** | 8.33 | 9.63 | 9.49 | |
| **310** | 7.69 | 9.09 | 6.44 | |
| **311** | 13.28 | 17.10 | 13.78 | |
| **312** | 8.33 | | | |
| **314** | 5.65 | 7.60 | 7.91 | |
| **315** | 9.10 | 8.59 | 8.30 | 8.12 |
| **316** | 7.39 | 7.80 | | |
| **317** | 7.10 | 6.77 | 6.65 | 8.49 |
| **320** | 14.24 | 16.21 | | |
| **322** | 8.82 | 8.43 | 8.52 | |

**Evaluation Results**

Table 6 shows Velocity average and TUG average at a given time stamp $t0$-$t4$. Statistical measurements for the velocity average and TUG average such as variance, standard deviation, mean, median and the correlation coefficient (Pearson).

Table 6: Velocity average and TUG average at a given time stamp $t0$-$t4$.

| | t0 | t1 | t2 | t3 | VAR | STD | Mean | Median | Corr |
|---|---|---|---|---|---|---|---|---|---|
| Vel. | 0.53 | 0.54 | 0.54 | 0.51 | 0.0003 | 0.017 | 0.529 | 0.533 | 0.206 |
| TUG | 9.57 | 10.17 | 9.29 | 9.51 | 0.1415 | 0.376 | 9.635 | 9.542 | |

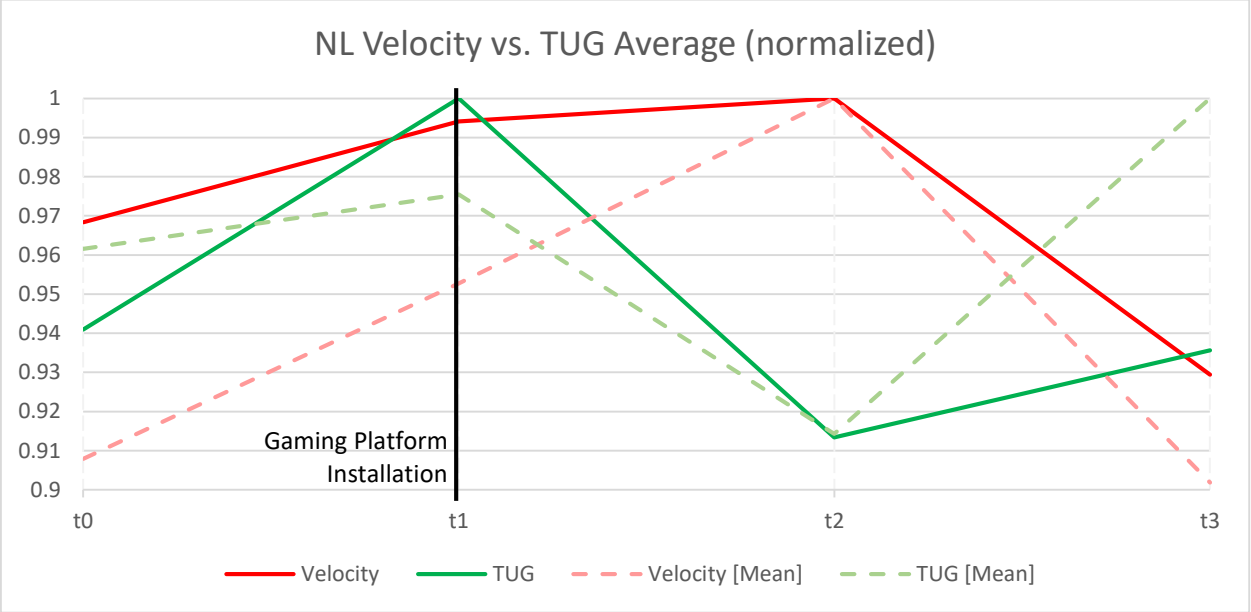


Figure 30: Velocity average (red) and TUG average (green) over time

**Discussion**

The progression of the participant group of the Netherland experiment, is given by Figure 30. Here, the gaming platform was installed at time stamp $t1$. It can be seen that the velocity average, similar to the Austrian data set, increases after the installation. However, there is a large drop in the velocity average between the time stamps $t2$ and $t3$. The reason for this is the lack of data points for the time stamp t3 (only 4 data points – see Table Table 6 (a)) and one unusually slow participant with an average velocity of 0.39ms, which represents the minimal velocity average in both data sets (ignoring participant 304 of Netherland data set). It is likely, that if more data points were available, the velocity average would at least stay at $t2$ levels. Ignoring the unusually slow participant and computing the velocity average between the 3 reasonable data points at $t3$, would give a velocity average of 0.54ms, which is even greater than 0.51ms at $t2$ and in line with the not unreasonable assumption that training improves mobility. Interestingly, other than before, the TUG average shows a clearer trend, as it drops significantly after installment of the training platform. The TUG average decreases by 6.4 - 8.7%, averaging at 7.6% over the training period. Of course, the large drop in the velocity average at $t3$ completely distorts the measurement of the correlation coefficient, which now has a value of 0.206. Because of this, a Linear Regression t-Test for statistical significance was not conducted, as it would not be interpretable. An evaluation regarding the nature of the relationship between velocity average and TUG average is given in Section 6.4.3.

### 6.4.3 Velocity/TUG Transfer Function

A regression analysis performed using both data sets (AT and NL), showing the linear fit to the Dutch data set is given in Figure 31. The ln fit to the combined data set (red), 2nd order polynomial (blue) and third order polynomial (green) fit, as well as the corresponding equations are shown.

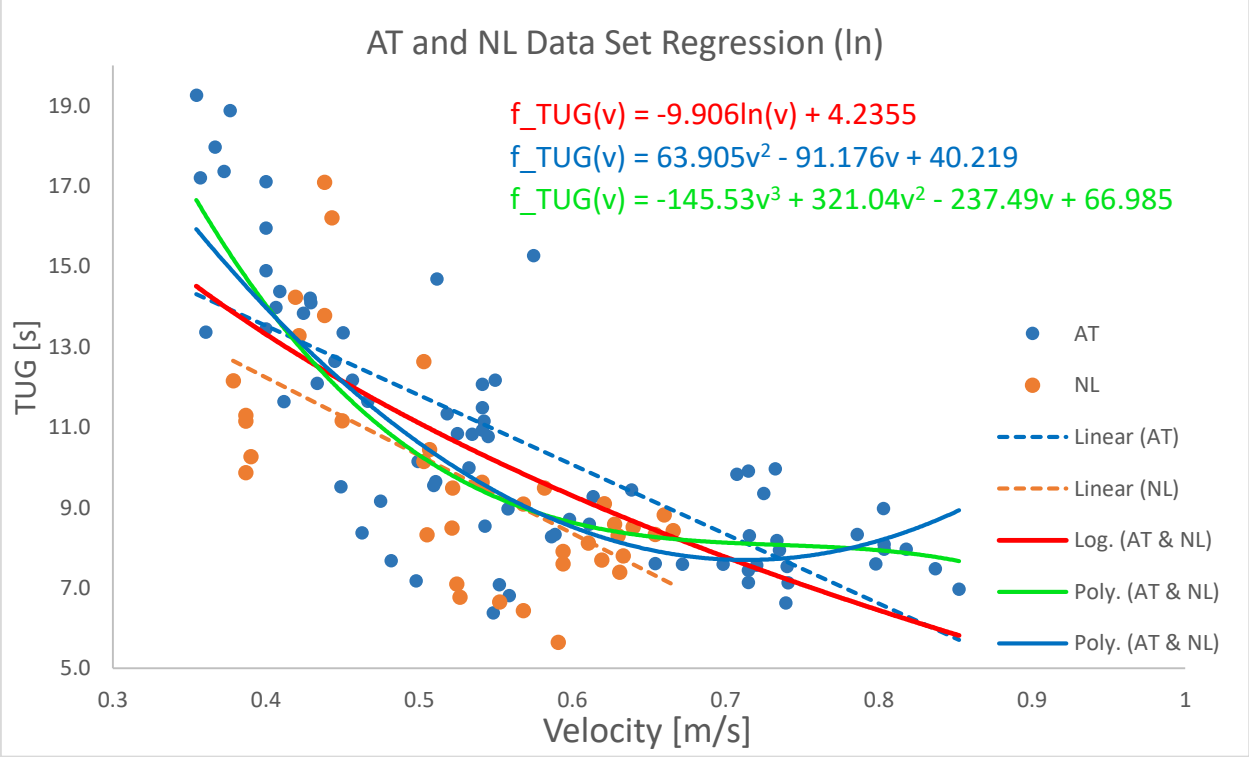


Figure 31: Regression analysis using both data sets (AT and NL), showing the linear fit to the Austrian (blue dotted) and the Netherland data set (orange dotted).

Table 7 gives an overview of the Mean Absolute Difference and Prediction Error of the different models. The Prediction Error is defined as the MAD minus a constant value of 1.055s, which represents the average TUG measurement error, attributed to human response time as shown in Figure 23.

Table 7: Mean Absolute Difference (MAD) and Prediction Error

| Model | MAD [s] | Prediction Error [s] |
|---|---|---|
| **ln** | 1.636 | 0.581 |
| **2nd order polynomial** | 1.437 | 0.382 |
| **3rd order polynomial** | 1.404 | 0.349 |

Figure 32 shows the Velocity/TUG transfer functions for the ln, 2nd order polynomial, and 3rd order polynomial model. The green rectangle represents minimum/maximum values of both variables observed in the data set.

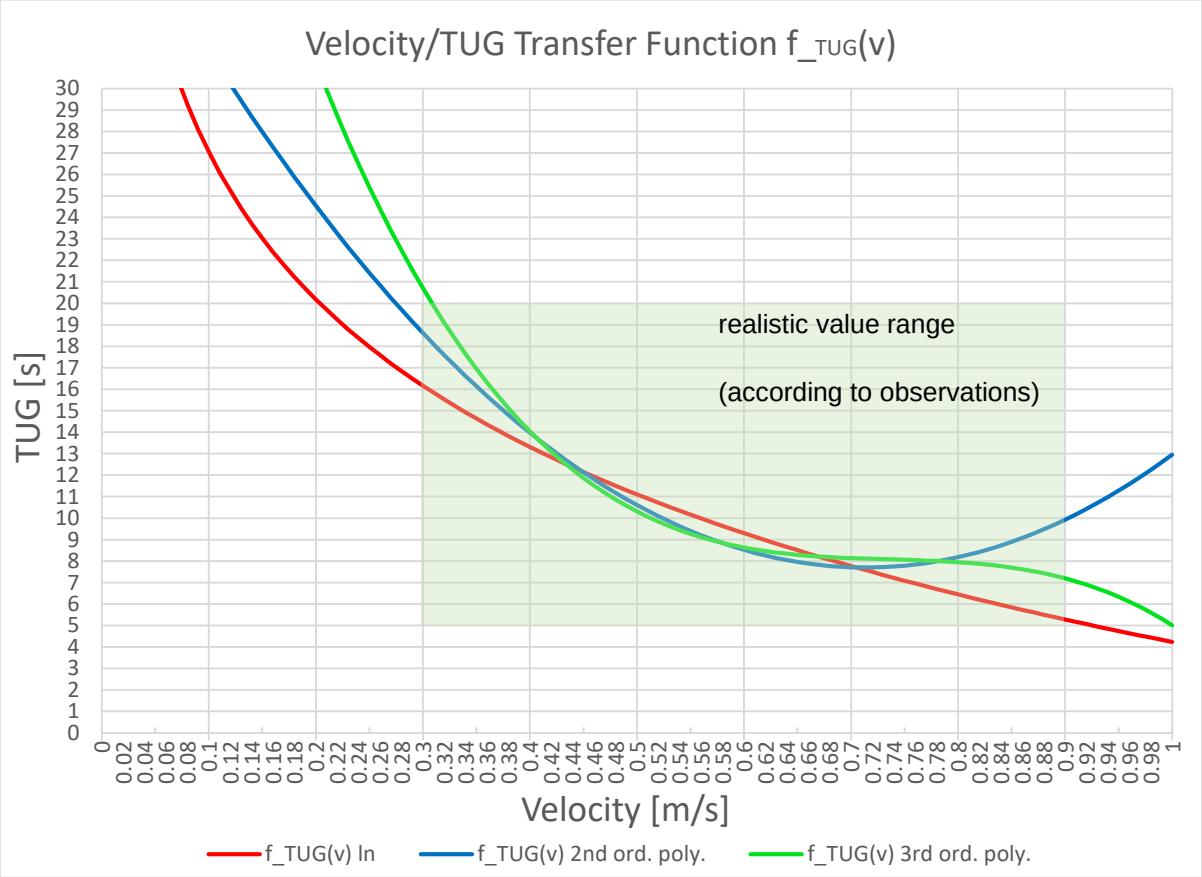


Figure 32: Velocity/TUG transfer functions for the ln (red), 2nd order polynomial (blue) and 3rd order polynomial (green) model.

As discussed in Section 6.4.1, the relationship between velocity average and TUG average has been shown to be of non-linear nature. Therefore, choosing a higher order model to fit the data is necessary for finding a transfer function that is sufficiently close to reality. Figure 31 shows the fit of suitable models, such as natural logarithm, 2nd order polynomial and 3rd order polynomial, to the combined data points of both data sets (AT & NL). Actual transfer functions for all models are given by Figure 32. The corresponding error metrics (MAD) for all models are given by Table 7. The 3rd order polynomial model did perform best with a MAD of 1.404s, when compared to the other models. It has been shown that the TUG measurement error, which can be attributed to human response time, is 1.055s on average (Figure 23). The Prediction Error (MAD – 1.055s), given by Table 7, accounts for this phenomenon and shows how the prediction of a transfer function compares to the actual measurement of a human observer. This shows that the best performing model (3rd order polynomial) can predict the TUG value from a velocity value with an error that is only 0.349s higher on average than the measurement error, produced by a human observer.

### 6.4.4 Conclusion

Data sets from both the Austrian and the Dutch experiment were evaluated. Evaluation results for the Austrian data set show that training with the gaming platform increased mobility, manifested as higher velocities. Participants could increase their velocity by 3.8 % on average over the course of the experiment. The TUG measurements for this experiment show no clear trend. For the Netherland experiment, velocity also tends to increase while TUG times decrease substantially (7.8% on average) over time, however, missing data points at the end of the experiment weaken the significance of the result. Furthermore, a transfer function between velocity and TUG was derived from the data points of both data sets. The resulting transfer function (3rd order polynomial) can predict the TUG time from a given velocity value with an accuracy (MAD 1.404s) that is close to the measurement error, produced by a human observer.

# 7 Geriatric Expertise and Clinical Trial

The contribution of GER to the project was mainly to assist in the development of a mobility model that should be used as a basis for game development. In order to tailor the games towards the needs of older persons which are: staying independent and to keep functional capacity GER recommended a mobility model that used each gaming person as his/her control. The advantage of this approach would have been that minor changes in mobility (e.g. due to intercurrent illness) could be picked up by the system resulting in an adaptation of the gaming mode or a warning.

A second part of GER's work was providing geriatric expertise for game development: Based upon GER's input, SIL developed of a game that helps to maintain functional capacity called the "vegetable garden".

Another focus of the GER was to provide mobility data from rather frail persons who still are living in an independent environment. For this reason, recruited three volunteers age >80 from a retirement home who gave informed consent. Initially GER had to eliminate several concerns about data safety as well as privacy in personal meetings. One person dropped out because of a non-traumatic vertebral fracture and had to be replaced. Currently mobility data from two persons are being analyzed. Person number 3 finishes in March 2019.

## 7.1 Clinical Trial

During the mid-term meeting GER proposed a randomized clinical trial using EnterTrain in the early postoperative phase in geriatric patients after a hip fracture. After an intensive discussion with the local ethics committee GER realized that randomization into two groups would not be feasible due to the lack of a sufficient effect size. GER therefore adapted the initial study protocol to an observational trial looking at the acceptance of an exergame in a clinical geriatric setting. The study was planned as a pilot trial in order to collect baseline data for a comparative study using an intervention group and a control group. The initial inclusion and exclusion criteria were strictly reserved to patients after a hip fracture who received a specific surgical procedure (ORIF) within 10 days before admission to GER's institution. Unfortunately, GER were not able to reach the desired number of participants for the clinical trial and had to change the protocol again. At this time, GER widened the inclusion criteria and, resubmitted an amendment to the local ethics committee. After acceptance of the new and final protocol GER started to recruit patients in June 2018. In the pre-trial phase GER had to instruct hospital based physiotherapists in specific aspects of geriatric assessment (baseline study exam) and in the use of the gaming system. GER then trained two study physicians recruitment and consent. Despite this effort only a few patients were eligible and only very few persons agreed to participate or used the exergame (currently n=5). Independently of the termination of the EnterTrain program GER will try to aim to recruit the final number of gaming participants (n=20).

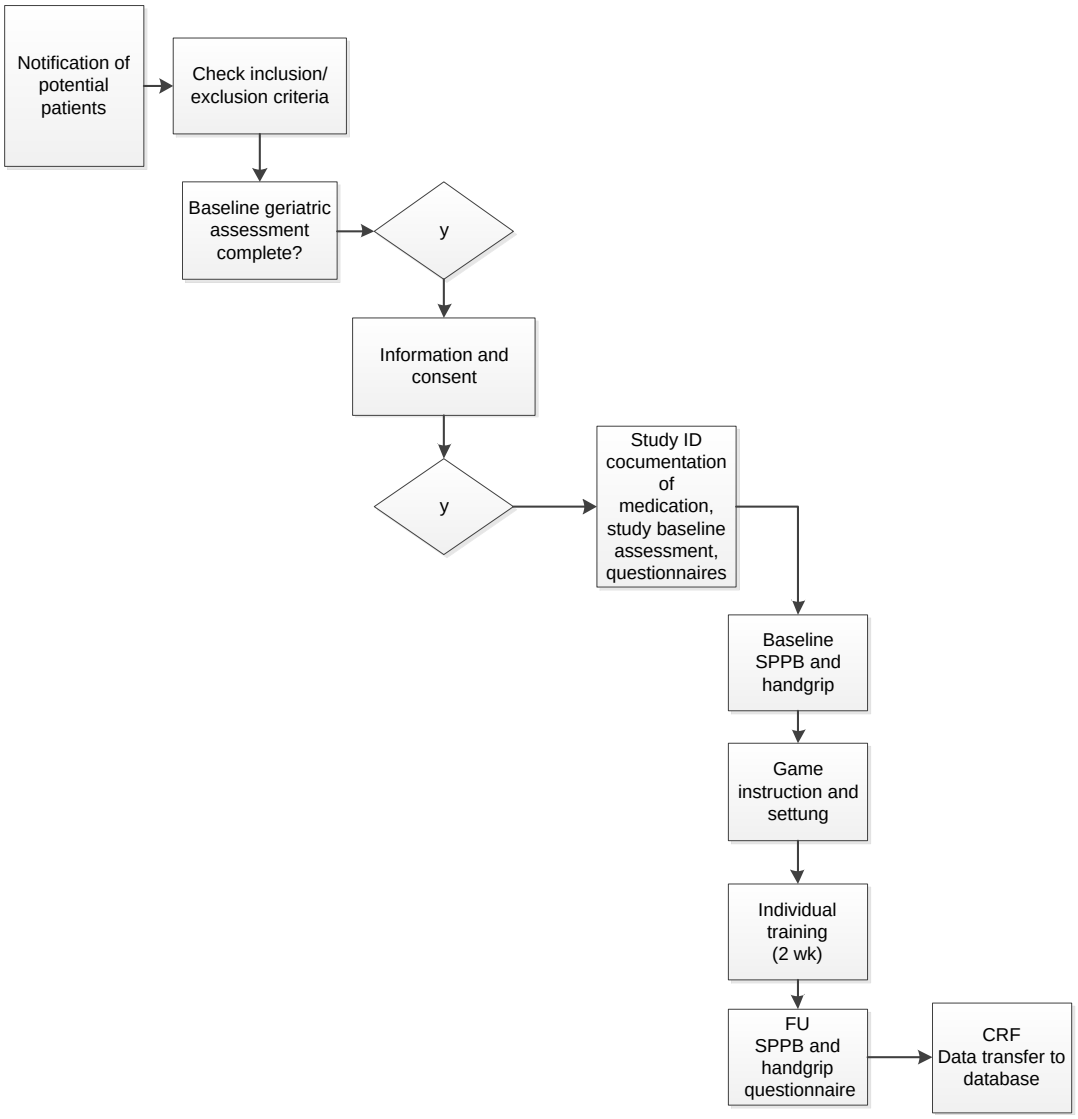


Figure 33: Study Schema

## 7.2 Results and Discussion

Due to the small sample size it is not possible to calculate mean values on the individuals. The unexpectedly high number of patients who refused to use the game only allows general observation and remarks. Since we will continue to recruit beyond the project phase we plan to publish our experiences at another time.

**Patient barriers**

We found that geriatric patients did not like to use the game because they were scared that they induce an error in the system or they had problems with the mobility tracker (getting into the capture area). Another reason for refusal was fear to damage the system. Sometimes patients forgot the instructions and did not dare to tell the staff members or they simply were not interested in gaming.

**Patient Rooms**
In order to allow gaming during a theoretical 24/7 period we installed the exergames on a trolley in the patient rooms. It turned out that standard double rooms were too small for permanent installation because the systems need a minimal distance between the gaming persons and the tracker. Given that two persons had their bedside tables, additional walking aids and/or wheel chairs we realized that usual patient rooms were too small to use the game.

**Staff barriers**
From a nursing perspective the nurses felt that the systems were in their way and (non-instructed) nurses did not feel comfortable with the systems. In addition, nurses who were not instructed also were not able to motivate the patients to use the games. Similarly, non-instructed therapists who were not part of the intervention team also did not motivate the patients to use the game. Finally, the study seemed not very well accepted by the hospital staff mainly due to poor interest in research questions and lack of time.

## 7.3 Summary and Conclusions

After a period of 10 months we were able to recruit 5 patients into the trial. Three of them completed the study. Personal (non-supervised) gaming time was only a few minutes. The small number of patient currently does not allow statistical analysis.

We still believe that geriatric medicine or rehabilitation as well as the prevention of functional decline can very good targets for exergaming. Thus, we continue to collect information about the use of the gaming platform as long as we can use the systems.

**Recommendation for Future Implementation**
Future implementations or clinical trials should beforehand convince clinical staff members (nurses, therapists) about the importance of such an intervention. Given that some professions feel competed by exergames there is also an emotional component that needs to be addressed. Thus, education and training about the potential benefits of exergaming and the current technology should be part of an introduction module for staff members. After training each staff member should dedicate one or two responsible “key persons” even if they are not directly involved in the study. This approach could help to reduce barriers.
As for the room we recommend to create dedicated gaming areas where patients could train under supervision. Only patients who have proven that they could handle the system without extra help should have access to gaming without assistance.

**Open Research Questions**
We still hope that we could draw additional conclusions after the number of originally planned patients is achieved. Ideally we then implement a randomized study in the way as it was designed originally. We will then be able to answer the effect of exergaming upon functional outcome after an acute event. The question if long term exergaming in a larger end-user population delays functional decline over time is still open.

# 8 Indication for further AAL research

The following paragraphs summarize main reflections upon experiences made throughout the EnterTrain project. The following sections will consider the main lessons learnt and indications for further AAL projects especially regarding the involvement of end-users and the target group, evaluation design, and the importance of thinking about an exit strategy early on.

**Target group**

Despite a requirement analysis including a quantitative survey and focus groups, it was challenging to recruit good matches of test users and real (imagined) end-users. Thus, we believe that it is important to ensure a certain flexibility to slightly adapt the target group throughout a trial phase. In the EnterTrain field trials, also people using walking aids at home - some were in rehabilitation and under guidance from physiotherapists after fall or surgery – could participate in testing the gaming platform. Further, although we provided a booklet of the system and games with pictures showing the system and the games, still some participants had no exhaustive idea of what they could expect from the trial period and the gaming platform. Thus, a demonstration movie or infographic would give participants an even better idea of what to expect and what is expected from them.

The field trial in the Netherlands was geographically very widespread thus it might help to find a target group that is geographically located within a small range, in order to also make meeting each other easier.

Additionally, it is crucial to consider manifold motivation and reasons to take part in an AAL project as a test user. Motivations to take part in the EnterTrain project included recruitment via personal contacts, being part of an international research project, being interested in technological details and the technical developments of the platform, helping (other) “older people”, and to personally staying or remaining fit.

**Evaluation design**

Throughout the project, we experienced the importance to ensure close contacts as well as regular visits and meetings with test users. Also in the final feedback regarding the study participation most test users stressed the importance to create opportunities to meet other test users, e.g. in the format of discussion groups. Further, the possibility to talk with technicians, and/or physiotherapists at group discussions could be encouraged more in the evaluation design. Especially given that it is usually only (social science) researchers who organize and participate in these events.

**Exit strategy (after the project ends)**

Most test users had the gaming platform installed for about 10 months in their homes, thus many participants got used to following regular exercises. Although some participants were very active anyway and followed their own activities and sports, some reported that the deinstallation of the platform was not so much appreciated. Thus, it proved very important to think about an exit strategy quite early on and collect ideas from project partners based on their experiences with the target group(s). This also shows appreciation for the time and efforts spent by participants. Participants of the EnterTrain field trial received a certificate, a booklet with exercises in alignment with movements they have done with the gaming platform (see Annex 11.4 for the German booklet), a step counter (in Vienna) and an App with exercises (in the Netherlands) at the end.

# 9 Conclusions

This report consolidated the main results of a ten-month field trial phase of the EnterTrain gaming platform with 37 test users in Austria and the Netherlands. This test phase was the second trial after a shorter 2-month field pilot with four participants in both countries. Participants between the ages 65 and 92 tested the exergaming platform with in total seven games in their homes and received regular visits by physiotherapists, researchers and technicians. Generally, the analysis showed that the exergaming platform was well received by most participants and played regularly especially within the first 5 to 6 months. The platform update, which took place halfway through the testing phase, added some functions, which was much appreciated by the participants. The addition of a new game was very important to keep some test users motivated and eager to play.

Some participants reported that they felt positive physical changes by regularly exercising with the platform, especially in reducing back pain or enhancing stability for the less fit group of participants. More specifically, participants, who were less mobile and/or currently recovering from an accident or surgery could benefit from the EnterTrain platform the most. Other test users, especially those who were very active, mobile and socially engaged, didn't report any (great) physical changes but were challenged mentally by some games (for instance arithmetic) and enjoyed the group discussions and exchanging ideas there with other participants. Additionally, for some test users the biggest motivation to start doing the exercises with the system was the fact that the exercises were presented in playing a game. The participants said that they are not so enthusiastic about their regular exercises given by a physiotherapist. Thus, the gaming aspect made exercising appealing and fun again for some participants. Also during the trial phase, no accidents or falls occurred due to participants playing the games.

Further, feedback about the participation in the research project by most test users was very positive, especially regular visits by physiotherapists and researchers, as well as the focus group discussions where test users could meet were very positively received.

Concluding, crucial feedback from end-users was gathered through interviews, group discussions, mobility assessments and surveys throughout the (first and) second field pilot phase(s) which greatly influences the further development and marketability of the EnterTrain system.

# 10 Literature

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Witzel, Andreas. 2000. The Problem-Centered Interview. Forum: Qualitative Research, 1(1), Art (22)

# 11 Appendix

## 11.1 Guidelines (third) User Interview

1. Introduction

Thank you very much for taking the time for this interview. You have now tested the games for several months and I would like to talk to you about how it is going for you and how you like the games. Can I record the interview? Of course all information is kept anonymously and won't be passed on to third parties.

2. Questions

Using the Gaming Platform

- In the beginning, I would like to talk about the test phase in general. Please tell me about the experiences you have made with the gaming platform within the last month
- How has playing the games changed since the beginning of the test phase?
- What motivation do you have to play the games?
- How has your motivation changed to play the games since the beginning of the test phase?
- What do you think about the gaming updates?
- How are you doing with the new game "vegetable garden"?
- How are you doing with the new feature, where you can see your achieved points?
- To what extent has something in your sense of wellbeing changed since you play the games?

Implications for Everyday Life

- How does the platform fit into your daily routine?
- How long do you feel like you are playing the games?

Usability

- In how far have there been moments, where you wanted to or actually stopped playing the games?
- Have there been moments where you noticed problems with the gaming platform that you couldn't immediately take care of yourself?
- How do you feel about the technical aspects of the gaming platform? (for instance: turning the system on/off; operating the touchscreen)

Self-description in regards to new technologies

- In what ways has your knowledge about new technologies changed by using the gaming platform in the last months?

Feedback regarding participation to the study

- To what extend do you talk about the gaming system and this research project with your friends or family?
- Please describe your experiences with the study participation until now.
- To what extend would you describe your personal expectations for taking part in this study?
- Are there any aspects of the study that you wish to talk about in more detail?

## 11.2 Guidelines Focus Group

1. Introduction

Dear participants,

Thank you all for coming, I hope you've found the location easily. My name is x and I'm from the (Name of Institution). Joining us is my colleague y, also from (Name of institution).

We've gathered today to discuss the EnterTrain platform and we'd like to hear your opinions about it. You have all agreed to take part in this discussion group voluntarily since you have tested and used the EnterTrain platform playing games for the past month. We'll record the discussion, you'll of course be anonymized, no names will appear in publications or documents and the information gathered will not be passed on to third parties.

Today we want to talk about the platform and how you feel with it being in your home and having it around in your living space. Also if you have any concerns or questions regarding the platform and the test phase. Generally, we are interested in what you think of the platform and what you like more and what you like less, but we'll discuss this at a later point.

We appreciate every comment; it doesn't matter if it's positive or negative. All comments are very helpful for us, so please feel free to say what you think at all times.

Before we start, I would suggest a few things to make the discussion easier. We appreciate comments from everyone in the group, but we would appreciate it if only one person speaks at a time.

Since I'll moderate the discussion, I'll be asking various questions time after time to make sure we have a little diversification. I will ask about (x number of questions) questions.

I'd now ask you to introduce yourself. Please tell us your name, age and your experiences with ICTs (smartphones, computers, tablets etc.).

1. Questions to main topics

You have tested the platform for about one month. How are you holding up? What are your first impressions regarding the platform?

- What have you liked the most about the platform?
- What have you liked the least about the platform?
- Which games or kinds of games would you wish for additionally in the platform?
- Is there anything you would modify about the platform until now? If yes: What would you modify?

How do you feel about the technical aspects for instance operating the touchscreen or starting the platform?

- Have any problems/errors occurred while operating the platform until now? If yes: Which problems have occurred and in which situations?
- Have we missed something? Or are there any questions you want to ask other participants?

## 11.3 Pre-Post Survey

EnterTrain Questionnaire

The survey discusses the topics health and technology. We ensure full confidentiality of all your answers. Only the University of Vienna and NFE have access to this data.

1. How would you generally describe your current health status?

| Very good | Good | Fair | Poor |
|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ |

2. Do you feel or are you constrained when performing the following exercises?

| | | Fully applies | Partly applies | Appliesto a lesser extent | Does not apply |
|---|---|---|---|---|---|
| a | Walk at a fast pace | ☐ | ☐ | ☐ | ☐ |
| b | Vacuum clean | ☐ | ☐ | ☐ | ☐ |
| c | Carry a shopping bag | ☐ | ☐ | ☐ | ☐ |
| d | Walk several sets of stairs | ☐ | ☐ | ☐ | ☐ |
| e | Walk one set of stairs | ☐ | ☐ | ☐ | ☐ |
| f | Bend over | ☐ | ☐ | ☐ | ☐ |
| g | Walk more than 1 kilometre on foot | ☐ | ☐ | ☐ | ☐ |
| h | Walk across a big street | ☐ | ☐ | ☐ | ☐ |
| i | Take a bath | ☐ | ☐ | ☐ | ☐ |

How does the following statement apply?

3. My current health status limits the contact I have with my family and friends.

| Fully applies | Partly applies | Applies to a lesser extent | Does not apply |
|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ |

4. The following set of questions discuss your personal experience of pain. Please indicate, how the following statements apply.

| | | Fully applies | Partly applies | Applies to a lesser extent | Does not apply |
|---|---|---|---|---|---|
| a | I do not feel any pain. | ☐ | ☐ | ☐ | ☐ |
| b | Due to my current pain I'm limited in to realize basic activities at home (for example getting dressed, taking a shower, brushing teeth) | ☐ | ☐ | ☐ | ☐ |
| c | Due to my current pain I'm limited to realize daily- and householdactivites at home (for example cooking, washing clothes, cleaning up, filling and emptying the dishwasher) | ☐ | ☐ | ☐ | ☐ |

5. I would like to ask some questions about how concerned you are about the possibility of falling. For each of the following activities, please circle the opinion closest to your own to show how concerned you are that you might fall if you did this activity. Please reply thinking about how you usually do the activity. If you currently don't do the activity (example: if someone does your shopping for you), please answer to show whether you think you would be concerned about falling IF you did the activity.

| | | Not at all concerned 1 | Somewhat concerned 2 | Fairly concerned 3 | Very concerned 4 |
|---|---|---|---|---|---|
| 1 | Cleaning the house (e.g. sweep, vacuum, dust) | ☐ | ☐ | ☐ | ☐ |
| 2 | Getting dressed or undressed | ☐ | ☐ | ☐ | ☐ |
| 3 | Preparing simple meals | ☐ | ☐ | ☐ | ☐ |
| 4 | Taking a bath or shower | ☐ | ☐ | ☐ | ☐ |
| 5 | Going to the shop | ☐ | ☐ | ☐ | ☐ |
| 6 | Getting in or out of a chair | ☐ | ☐ | ☐ | ☐ |
| 7 | Going up or down stairs | ☐ | ☐ | ☐ | ☐ |
| 8 | Walking around in the neighbourhood | ☐ | ☐ | ☐ | ☐ |
| 9 | Reaching for something above your head or on the ground | ☐ | ☐ | ☐ | ☐ |
| 10 | Going to answer the telephone before it stops ringing | ☐ | ☐ | ☐ | ☐ |
| 11 | Walking on a slippery surface (e.g. wet or icy) | ☐ | ☐ | ☐ | ☐ |
| 12 | Visiting a friend or relative | ☐ | ☐ | ☐ | ☐ |
| 13 | Walking in a place with crowds | ☐ | ☐ | ☐ | ☐ |
| 14 | Walking on an uneven surface (e.g. rocky ground, poorly maintained pavement) | ☐ | ☐ | ☐ | ☐ |
| 15 | Walking up or down a slope | ☐ | ☐ | ☐ | ☐ |
| 16 | Going out to a social event (e.g. religious service, family gathering or club meeting) | ☐ | ☐ | ☐ | ☐ |
| Sub Total | | ☐ | ☐ | ☐ | ☐ |
| | | | | Total | /64 |

6. The following set of questions discusses your personal attitude towards technology. Please, indicate how the following statements apply.

| | | Fully applies | Partly applies | Applies to a lesser extent | Does not apply |
|---|---|---|---|---|---|
| a | In regard to new technologies I am very curious. | ☐ | ☐ | ☐ | ☐ |
| b | Dealing with new technological devises is usually overwhelming for me. | ☐ | ☐ | ☐ | ☐ |
| c | I'm interested to use new technical devices. | ☐ | ☐ | ☐ | ☐ |
| d | If I ran into problems with technological devises, I usually solve it myself. | ☐ | ☐ | ☐ | ☐ |
| e | I am scared to break new technological devises. | ☐ | ☐ | ☐ | ☐ |
| f | Whether I am success in dealing with new technologies, mostly depends on myself. | ☐ | ☐ | ☐ | ☐ |

7. How often do you use the following devises?

| | | Daily | At least once a week | At least once a month | Less than once a month | Never/ I do not have such a device |
|---|---|---|---|---|---|---|
| a | Radio | ☐ | ☐ | ☐ | ☐ | ☐ |
| b | Television | ☐ | ☐ | ☐ | ☐ | ☐ |
| c | Mobilphone (Telephone with a keyboard) | ☐ | ☐ | ☐ | ☐ | ☐ |
| d | Smartphone (Telephone with a touchscreen) | ☐ | ☐ | ☐ | ☐ | ☐ |
| e | Computer | ☐ | ☐ | ☐ | ☐ | ☐ |
| f | Tablet (like a computer with a Touchscreen) | ☐ | ☐ | ☐ | ☐ | ☐ |
| g | Internet | ☐ | ☐ | ☐ | ☐ | ☐ |

If you have answered the question 6e with the category „*Never/ I don't have such a devise*" then please skip the last question.

Best possible skills/ knowledge


Worst possible skills/ knowledge

8. How would you rate your computer skills on the scale on the left hand side?

To help you assess how good or bad your computer skills are, we have drawn a scale similar to a thermometer. The best possible skills are marked with a "100", the worst possible computer skills with "0". We would like to ask you to indicate on this scale how good or bad you believe your personal computer skills are. Please put your cross at the place of the scale that best reflects your computer skills.

9. On a scale from 1 to 10, how much would you like to keep the EnterTrain System after this testing period? 1 means that you dont want to keep the EnterTrain System at all, 10 means that you would really like to keep the EnterTrain System.

☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

**1 2 3 4 5 6 7 8 9 10**

10. In general, do you feel like the following things have changed over the course of last the last year?

| | Has changed positively | remained the same | has changed negatively |
|---|---|---|---|
| **My health status** | ☐ | ☐ | ☐ |
| Handling of technical devices | ☐ | ☐ | ☐ |

THANK YOU FOR PARTICIPATION!

## 11.4 Booklet


# DELIVERABLE D 3.2

## User Report

## Inhalt



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# 1. Vorwort

Sehr geehrte Teilnehmerin / sehr geehrter Teilnehmer!

Herzlichen Dank dafür, dass Sie so ausdauernd und erfolgreich beim Enter-Train-Projekt mitgewirkt haben.

Unser Ziel ist es, mit EnterTrain Ihre Beweglichkeit, Gesundheit und Selbständigkeit so lange wie möglich zu erhalten.

Durch Ihre Teilnahme an unserer Pilotstudie zur Testung neuer Bewegungsspiele mit dem EnterTrain-System haben Sie einen wesentlichen Beitrag zu seiner Weiterentwicklung geleistet. Dank Ihren Anregungen sind wir unserem Ziel einen großen Schritt nähergekommen.

Als Dankeschön für Ihr Engagement haben wir Ihnen im vorliegenden Büchlein eine kleine Sammlung an Trainingsübungen und –spielen zusammengestellt. Diese knüpfen an die Spiele, die Sie mit dem Enter Train System durchgeführt haben, an.

Wir hoffen, Ihnen mit diesen Anregungen eine Ergänzung und Abwechslung zu ihren Bewegungsaktivitäten zu ermöglichen, und dass Ihre Bewegungsfreude und Ihre Mobilität somit auf vielfältige Weise erhalten bleiben.

Das Büchlein beginnt mit einer kurzen Einleitung, in der Grundlagenwissen und allgemeine Empfehlungen zum Thema Bewegung und Training zusammengefasst werden.

Auf den weiteren Seiten finden Sie 14 ausgewählte Trainingsübungen bzw. Bewegungsspiele.

Für jedes Ihrer früheren EnterTrain-Spiele werden jeweils zwei Aufgaben mit ähnlichem Bewegungsablauf angeboten, die sich bezüglich ihrer Schwierigkeit und/oder ihrem Charakter (Trainingsübung oder Bewegungsspiel) voneinander unterscheiden.

In Summe trainieren all diese Trainingsübungen und Bewegungsspiele die Kraft, Beweglichkeit und Koordination aller Körperregionen und Muskelgruppen. Außerdem werden Gleichgewicht, Aufmerksamkeit, Wahrnehmung, und kognitive Fähigkeiten geschult.

Wir wünschen Ihnen viel Vergnügen und gutes Gelingen!

# 2. Einleitung

## 2.1. „Leben ist Bewegung“ – Wie viel Bewegung ist notwendig?

Unser Körper braucht regelmäßige Bewegung, um seine Strukturen und Funktionen aufrecht zu erhalten. Muskeln, der Bewegungsapparat, Kreislauf, Stoffwechsel, Immun-, Hormon- und Nervensystem benötigen regelmäßige Reize, die eine bestimmte Schwelle überschreiten und damit Anpassung und Verbesserung auslösen.

Bewegungstraining wirkt sich nicht nur auf die körperliche Leistungsfähigkeit und Belastbarkeit aus, sondern auch auf Aufmerksamkeit, Wahrnehmung, Stimmung, Aktivierung, und geistige Fähigkeiten wie Lernfähigkeit und Kreativität. So fördern z.B. koordinativ schwierigere Bewegungsformen die Neubildung von Nervenverbindungen (Synapsen).

Die medizinische Forschung der vergangenen Jahrzehnte hat gezeigt, dass regelmäßige Bewegung allen guttut: Frauen und Männern aller Altersgruppen, und auch chronisch Kranken sowie Menschen mit besonderen Bedürfnissen.

Bewegungstraining kann altersbedingten Abbauerscheinungen entgegenwirken und damit helfen, die Selbständigkeit und die Lebensqualität auch in späteren Lebensjahren zu erhalten.

Wenn Sie nicht sicher sind, wie weit Sie sich in ihrem aktuellen Gesundheitszustand belasten dürfen, dann besprechen Sie dies mit Ihrem Ihrer Ärztin oder ihrem Arzt.

Die neuesten Empfehlungen des American College of Sports Medicine 2018 beschreiben, welche Art und welcher Umfang von Bewegungsaktivität nötig sind, um das Kreislaufsystem, Knochen, Muskeln, Nerven, und den Organismus insgesamt gesund zu erhalten:

Falls Sie die Empfehlungen nicht erreichen, gilt: Ein bisschen Bewegung ist besser als gar keine Bewegung!

Und noch etwas: Langedauerndes Sitzen ist immer ein Gesundheitsrisiko, egal wie viel Sport man betreibt –> Für sitzende Tätigkeiten oder größere Reisen gilt: Stehen Sie so oft wie möglich auf!

## 2.2. Empfehlungen für ein optimales Bewegungstraining:

Gesundheitsfördernde Bewegungsaktivitäten beinhalten ein Training von:

Ausdauer + Kraft + Beweglichkeit + Neuromuskulären Fähigkeiten

### 2.2.1. Ausdauertraining

**Wichtig** für Kreislauf, Stoffwechsel, Immunsystem

**Bewegungsformen**:

Gehen, Radfahren, Stiegen steigen, Schwimmen, Wassergymnastik, Tanzen, ...

**Umfang und Intensität**:

- mindestens 150 Minuten bis 300 Minuten pro Woche mit mittlerer Belastung (ins Schwitzen kommen)

oder

- mindestens 75 Minuten bis 150 Minuten mit höherer Belastung (tiefer und schneller atmen, aber nicht keuchen)

oder

- eine Kombination aus Phasen mit mittlerer und höherer Belastung, und entsprechender Zeitdauer
- Noch höhere Umfänge bringen auch noch gesundheitliche Vorteile, der Unterschied ist aber nicht mehr so hoch.

### 2.2.2. Krafttraining

**Wichtig** für den Erhalt von Muskelmasse, Knochendichte, Stabilisierung von Gelenken und Wirbelsäule, Festigkeit von Sehnen, Bändern und Bindegewebe

**Bewegungsformen:**

Gymnastik (z.B. Kniebeugen) mit und ohne Zusatzgeräte (z.B. Theraband), Training mit Kurz- oder Langhanteln, Maschinentraining, Klettern, Turnen auf Geräten, ...

**Übungen** zur Kräftigung der Bein-, Becken-, Rücken-, Bauch-, Schulter- und Armmuskulatur;

Abwechslungsreiche Übungsauswahl bringt besseren Kraftzuwachs

### 2.2.3. Beweglichkeitstraining

**Wichtig** für den Erhalt des Bewegungsumfanges in Gelenken und Wirbelsäulen, zur Vermeidung von Muskelverkürzungen, und für die Elastizität von Sehnen, Bändern und Bindegewebe

**Bewegungsformen:**

Gymnastik (Mobilisations- und Dehnungsübungen, Schwunggymnastik), Yoga, ...

**Unterschiedliche Übungen und Methoden** können kombiniert werden

### 2.2.4. Neuromuskuläres Training

**Wichtig** für den Erhalt von Gleichgewicht, Koordination,

Propriozeption (Bewegungswahrnehmung und -steuerung)

**Übungsformen:** Wird besonders durch Bewegungsspiele, durch ungewohnte und durch komplexe Bewegungsabläufe trainiert

## 2.3. Umsetzung des Bewegungstrainings im fortgeschrittenen Lebensalter

Diese Richtwerte für Erwachsene gelten auch für Menschen im fortgeschrittenen Lebensalter, wobei Folgendes besonders berücksichtigt werden sollte:

Besonders förderlich wirken mindestens wöchentliche Trainings mit mehreren Komponenten, d.h. die sowohl Kraft als auch Ausdauer und zusätzlich neuromuskuläre Fähigkeiten, insbesondere Gleichgewicht, fordern.

Die jeweiligen Intensitäten sollen bzw. müssen dem individuellen Leistungsniveau angepasst werden, wobei auch kurzfristige Schwankungen (Tagesverfassung) eine Rolle spielen.

Falls größere gesundheitliche Einschränkungen bestehen, kann der empfohlene Trainingsumfang eventuell nicht erreicht werden. Stattdessen sollte versucht werden, den größtmöglichen Trainingsumfang zu erreichen, der noch beschwerdefrei möglich ist.

## 2.4. Bewegung für zwischendurch

Es muss nicht immer eine geplante Trainingsstunde sein: Im Laufe des Tages ergeben sich oft mehrere Gelegenheiten für jeweils ein paar Minuten Bewegung; sie wollen nur genutzt werden.

Zum Beispiel könnten Sie folgende Zeiten nutzen, um die eine oder andere Bewegungsübung durchzuführen: Während Ihre Lieblings-Fernseh-oder Radiosendung läuft (zu Beginn, in Werbepausen, während der Musikstücke, und am Ende); oder während Sie warten, bis etwas in der Küche fertig wird (zum Beispiel der Kaffee oder Tee).

# 3. Trainingsübungen und Bewegungsspiele für Fortgeschrittene

Im Folgenden finden Sie insgesamt 14 Aufgaben (Trainingsübungen bzw. Bewegungsspiele): Für jedes ihrer früheren EnterTrain-Spiele haben wir Ihnen zwei Aufgaben zusammengestellt, die ähnliche Bewegungsabläufe beinhalten bzw. auf diesen aufbauen.

| Aufgaben | statt folgendem Enter Train Spiel |
|---|---|
| 1 u. 2 | Statt „Bingo“ |
| 3 u. 4 | Statt „Fuchs“ |
| 5 u. 6 | Statt „Puzzle“ |
| 7 u. 8 | Statt „Maulwurf“ |
| 9 u. 10 | Statt „Arithmetik“ |
| 11 u. 12 | Statt „Tiefseetauchen“ |
| 13 u. 14 | Statt „Gemüsegarten“ |

Für jede Aufgabe gibt es zwei Schwierigkeits- bzw. Intensitätsstufen. Beginnen Sie mit Stufe 1, und steigern Sie bis zu jener Stufe, in der Sie das Gefühl haben gut ausgelastet zu sein.

Für einige der untenstehenden Aufgaben sind Therabänder vorgesehen. Je nach Farbe benötigen Sie unterschiedlich viel Kraft um die Bänder auseinanderzuziehen. Das einfachste Band hat die Farbe beige, dann kommt gelb, das nächst schwierigere ist rot, gefolgt von blau, schwarz, silber und gold. Je nach Fortschritt mit den Übungen können Sie den Schwierigkeitsgrad verändern, indem Sie ein Band mit anderer Farbe wählen.

Sie können sich diese Aufgaben einzelweise vornehmen und über die Woche bzw. über den Tag verteilen, oder in einer längeren Trainingseinheit hintereinander durchführen.

Als kleinen Anreiz auch zum Ausdauertraining empfehlen wir Ihnen darüber hinaus, gelegentlich einen Schrittzähler zu tragen und zu versuchen, pro Tag möglichst viele Schritte zu sammeln.

Wählen Sie für Ihr Training Zeiten, zu denen Sie sich wach und fit fühlen und genug Ruhe und Aufmerksamkeit zur Durchführung finden.

Beginnen Sie neue Übungen langsam und steigern Sie allmählich, was Bewegungsumfang, Krafteinsatz und Geschwindigkeit betrifft.

Wenn Sie in einen angenehmen Bewegungsfluss kommen, warm werden und spüren, dass Ihre Atmung tiefer und etwas schneller wird, dann haben Sie eine gute Intensität erreicht.

Falls es nicht so rund läuft, versuchen Sie mit kleinen Veränderungen im Bewegungsablauf zu einem besseren Bewegungsgefühl zu kommen.

Beenden Sie die Bewegung, falls Sie Schwindel oder Schmerzen verspüren oder sich unsicher fühlen.

Um die Übungs- bzw. Spieldauer festzulegen, gibt es mehrere Möglichkeiten:

- Sie geben sich selbst eine Zeit vor (sinnvoll: zwischen 2 und 10 Minuten pro Übung) und messen diese mittels Stoppuhr, Sanduhr, Wecker, oder einem Musikstück in der passenden Länge.

- Ausgehend von Ihren bisherigen Leistungen, nehmen Sie sich bei den Trainingsübungen eine bestimmte Wiederholungszahl vor (im Bereich zwischen 3 und 20).

- Sie geben sich bei den Bewegungsspielen selbst eine Zahl an Durchgängen / Spielzügen / Würfen vor.

- Sie geben sich bei den Bewegungsspielen selbst eine bestimmte Zahl an Bewegungswiederholungen vor (also jedes Mal, wenn Sie die richtige Zahl oder Karte für eine Bewegung haben).

- Sie führen die Aufgabe solange durch, solange Sie den Bewegungsfluss als gut und angenehm erleben.

Sofern es Ihnen damit gut geht, können Sie trainieren, so oft Sie dazu Lust haben.

Wir wünschen Ihnen viel Freude und Erfolg beim Training!

## 3.1. Statt Bingo: Rudern und Kniebeugen

Diese Trainingsübung kräftigt vor allem die Muskulatur der Beinstrecker, aber auch die Armbeuger und Schulterblattfixatoren.

**Trainingsgeräte:** Sie benötigen ein Theraband und einen Sessel

**Stufe 1**: Im Sitzen auf einem Sessel: Das Theraband mit den Händen an beiden Enden halten, die Füße in der Mitte hineinstellen und rudern: Im Wechsel

1. die Beine gegen den Widerstand des Bandes strecken; dabei die Enden des Therabandes mit den Händen zu den Hüften, und die Ellbogen und Schultern nach hinten-unten ziehen;

2. und wieder lockerlassen, d.h. die Beine beugen und die Arme strecken.

**Stufe 2:** Im Grätschstand: Das Theraband vor dem Körper mit beiden Händen an den Enden halten. Das Gewicht einmal auf das linke Bein verlagern und dieses beugen, und dabei das Theraband auseinanderziehen, dann das Gewicht wieder auf beide Beine verlagern und das Theraband lockerlassen, dann das Gewicht auf das rechte Bein verlagern und dieses beugen, und wieder das Theraband auseinanderziehen, dann das Gewicht wieder auf beide Beine verlagern und das Theraband lockerlassen.

## 3.2. Statt Bingo

Dieses Bewegungsspiel in zwei Varianten (mit einem Würfel oder mit Spielkarten) kräftigt die Muskulatur der Beinstrecker und teilweise auch der Armstrecker. Außerdem werden Aufmerksamkeit und Arbeitsgedächtnis trainiert.

**Spielgeräte**: Sie benötigen einen Würfel oder eine Packung Spielkarten, und einen Sessel.

**Variante 1: Bingo mit einem Würfel:**

**Stufe 1**: Legen Sie eine Zahl fest –

diese gilt für die nächste Spielrunde als Gewinnzahl.

Immer wenn die Gewinnerzahl gewürfelt wird, einmal aufstehen.

**Stufe 2**: Eine oder mehrere Zahlen stehen für eine bestimmte Bewegung, z.B.:

- 1 = Frei Aufstehen
- 2 = Aufstehen mit Aufstützen auf der Armlehne,
- 3 = Aufstehen in Schrittstellung,
- 4 = Aufstehen und die Arme nach oben strecken,

- 5-6 = Sitzen bleiben

**Variante 2: Bingo mit Spielkarten:**

Ziehen Sie eine Karte aus dem Stapel.

Diese legt die Farbe, Zahl oder die Figur fest,

die die Bewegung auslöst.

Immer eine Karte ziehen und jedes Mal aufstehen, wenn die Karte das Richtige zeigt

**Stufe 1**: Es gilt die richtige Farbe (Herz, Pique, Karo, Treff)

**Stufe 2**: Es gilt eine richtige Farbe und eine richtige Zahl/Figur

- Richtige Farbe: Frei Aufstehen
- Richtige Figur: Aufstehen mit Aufstützen

Wenn eine richtige Farbe und eine richtige Zahl/Figur zusammenkommen,

ergibt das zwei Übungen!

## 3.3. Statt Fuchs: Seitbeugen und Drehen

Diese Trainingsübung verbessert vor allem die Beweglichkeit der Wirbelsäule.

**Trainingsgerät**: Sie benötigen einen Sessel.

**Stufe 1**: Sitzen auf dem Sessel, die Arme hängen nach unten:

- Mehrmals langsam abwechselnd nach links und rechts beugen
- Mehrmals langsam abwechselnd nach links und rechts drehen.

**Stufe 2**: Sitzen auf dem Sessel, die Arme hängen nach unten: Jeweils mehrmals

- Aufstehen, Arme hochheben und nach links beugen, und wieder niedersetzen und die Arme absenken
- Aufstehen, Arme hochheben und nach rechts beugen, und wieder niedersetzen und die Arme absenken
- Aufstehen, Arme hochheben und nach links drehen, und wieder niedersetzen und die Arme absenken
- Aufstehen, Arme hochheben und nach rechts drehen, und wieder niedersetzen und die Arme absenken

## 3.4. Statt Fuchs: Flinker Fuchs

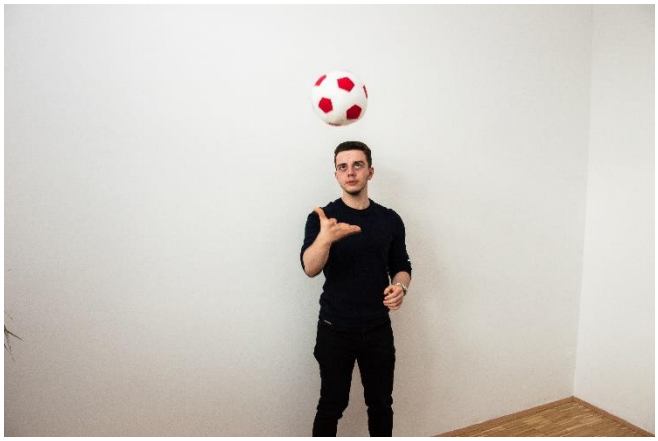
Mit diesem Bewegungsspiel trainieren Sie die räumliche Orientierung, und die Reaktionsfähigkeit.

**Spielgeräte:** Sie benötigen ein Tuch oder einen Luftballon und einen Sessel

**Stufe 1**: Im Sitzen hochwerfen und fangen

**Stufe 2:** In der Bewegung (am Platz gehen, rechts/links, vor/rück steigen,...)

Hochwerfen und Fangen



## 3.5. Statt Puzzle: Schwimmbewegungen

Mit dieser Trainingsübung trainieren Sie die Kraft und Beweglichkeit der Muskulatur von Armen, Schultergürtel und Oberkörper.

**Trainingsgerät**: Sie benötigen einen Sessel.

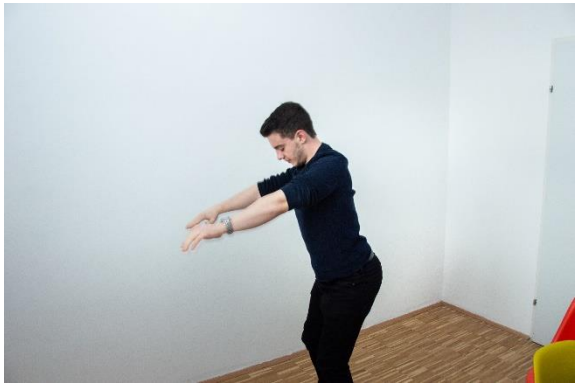
**Stufe 1**: Im Sitzen oder Stehen

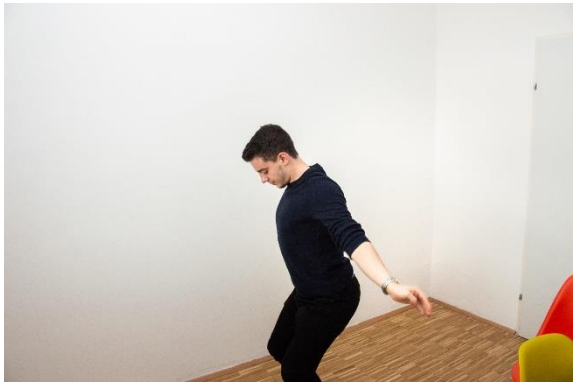
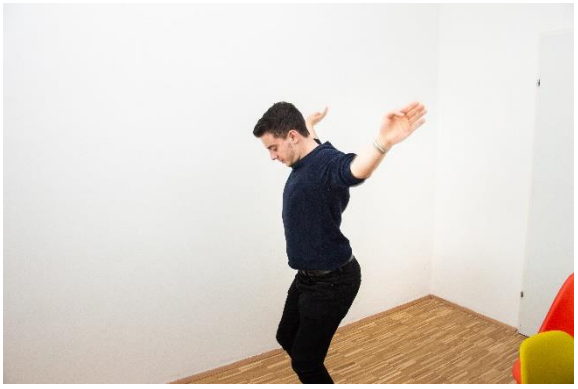
- Brustschwimmbewegungen horizontal
- Brustschwimmbewegungen vertikal



**Stufe 2**: „Delphinschwimmen":

Im Stehen kleine Kniebeugen ausführen und gleichzeitig beide Arme vorwärtskreisen

## 3.6. Statt Puzzle: Kartenglück

Mit dieser Übung trainieren Sie die Kraft und Beweglichkeit der Muskulatur von Armen, Schultergürtel und Oberkörper.

**Spielgeräte**: Sie benötigen eine Packung Spielkarten und einen Sessel

Jedes Mal, wenn die richtige Farbe gezogen wurde, folgende Übung (vgl. 3.5):

**Stufe 1**: Brustschwimmbewegung

**Stufe 2**: „Delphinschwimmen"

## 3.7. Statt Maulwurf: Tanzen

Diese Übung trainiert Gleichgewicht, Beinkraft, und, wenn Sie mehrere Musikstücke durchhalten, die Ausdauer.

**Trainingsgeräte**: Sie benötigen einen Musikapparat oder Radio und eventuell einen Sessel.

Wählen Sie zu Beginn eine heitere aber nicht zu schnelle Musik, die Sie gerne hören, bzw. schalten Sie den Radio ein.

Finden Sie Ihren Rhythmus zur Musik und beginnen Sie mit kleinen Schritten, steigern Sie langsam die Schrittgröße und –schwierigkeit, soweit sie sich sicher fühlen.

Für die nächsten Durchgänge darf etwas flottere Musik gewählt werden.

Falls Sie sich im Stehen unsicher fühlen, können sie auch im Sitzen tanzen.

## 3.8. Statt Maulwurf: Die Maus erwischen

Mit dieser Übung trainieren Sie Beinkraft, Beweglichkeit, Gleichgewicht, räumliche Orientierung und Reaktionsfähigkeit.

**Spielgerät**: Sie benötigen für dieses Spiel einen „Ball" – das kann auch ein Wollknäuel, Reissäckchen, Tuch oder Luftballon sein – und einen Sessel.

Im Sitzen oder Stehen: Den Ball nur mit den Füßen antippen, bewegen, übersteigen, langsam wegrollen lassen und wieder abfangen, ...

Finden Sie jene Schwierigkeit und Geschwindigkeit heraus, mit der Sie sich sicher aber auch ein bisschen herausgefordert fühlen – wo es Spaß macht zu spielen.

## 3.9. Statt Arithmetik: Immer wieder aufstehen

Dieses Spiel trainiert die Kraft der Beinstrecker, die Beweglichkeit der Schultern, sowie Koordination und Gleichgewicht.

**Trainingsgeräte:** Sie benötigen einen Sessel.

**Stufe 1**:

Aufstehen und dabei einmal die Schultern nach hinten kreisen, und wieder niedersetzen.

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**Stufe 2**: Aufstehen mit Armkreis, auf die Zehenballen stellen und wieder niedersetzen.

## 3.10. Statt Arithmetik: Rechenkette

Dieses Bewegungsspiel trainiert je nach Stufe die Kraft der Beinstrecker, die Beweglichkeit der Arme, sowie Koordination und Gleichgewicht, aber auch Arbeitsgedächtnis und Rechenfähigkeiten.

**Spielgeräte**: Sie benötigen einen Würfel und einen Sessel

Im Sitzen auf einem Sessel: Würfeln und die Ergebnisse der Würfe zusammenzählen.

jedes Mal, wenn eine bestimmte Zahl überschritten wird, aufstehen.

**Stufe 1**: Jedes Mal wenn ein Vielfaches von 25 überschritten wird

**Stufe 2**:

- Bei jeder durch 4 teilbaren Zahl: Aufstehen mit Armkreis
- bei jeder durch 5 teilbaren Zahl: Aufstehen und auf die Zehenballen stellen.

## 3.11. Statt Tiefseetauchen: Kraft-Zug

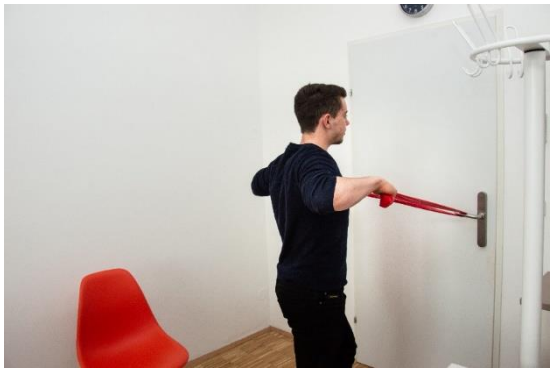
Mit dieser Übung trainieren Sie die Kraft der Arm-, Schulter- und Oberkörpermuskeln.

**Trainingsgerät**: Sie benötigen ein Theraband.

Theraband in Türschnalle einhängen und die Enden mit beiden Händen halten.

Mit dem Blick zur Tür stehen: In Schrittstellung die Arme gebeugt gegen den Widerstand des Therabands nach hinten ziehen, und dann wieder lockerlassen

Sie können das Theraband doppelt oder dreifach zusammenlegen, um den Widerstand zu erhöhen.

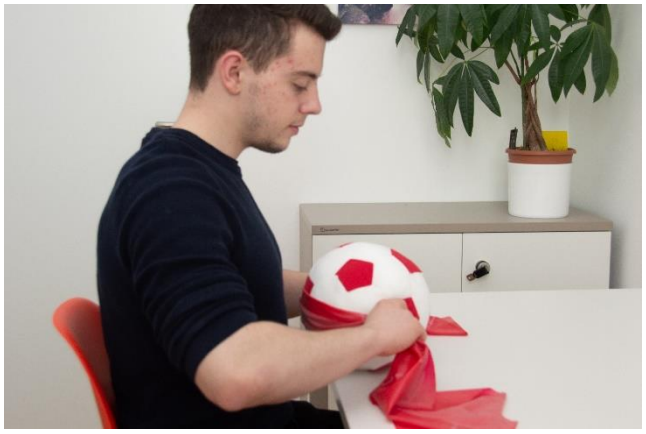


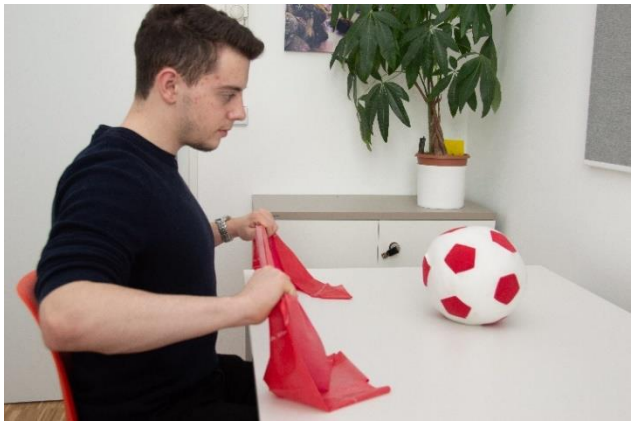
## 3.12. Statt Tiefseetauchen: Zielschiessen

Mit dieser Übung trainieren Sie die Kraft der Arm-, Schulter- und Oberkörpermuskeln.

**Spielgeräte**: Sie benötigen ein Theraband, ein Wollknäuel, einen Tisch und einen Sessel.

Im Sitzen auf einem Sessel, vor einem Tisch, das Theraband mit beiden Händen an beiden Enden halten. Das Wollknäuel liegt in der Mitte des Therabandes und dieses ganz nahe am Oberkörper. Jetzt die Schultern nach hinten-unten und die Hände ganz langsam auseinanderziehen. Indem sich das Theraband anspannt, wird das Wollknäuel nach vorne geschnellt. Versuchen Sie damit ein Ziel auf dem Tisch (z.B. Brotkorb) zu treffen.

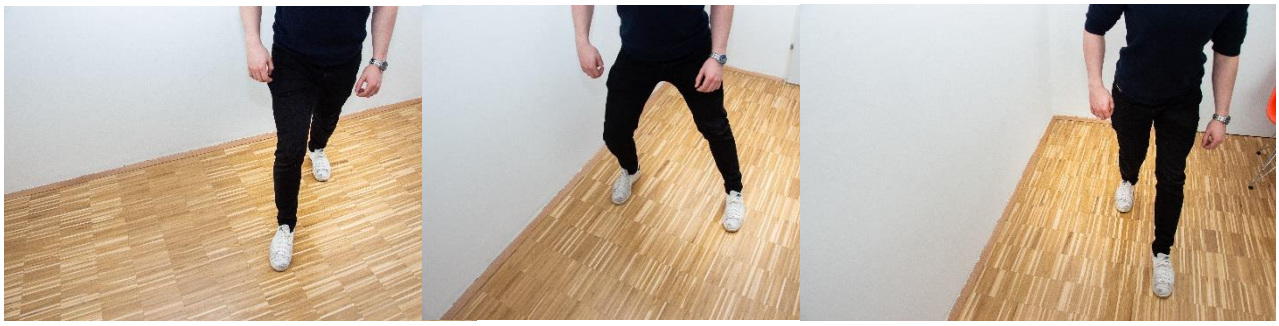




## Statt Gemüsegarten: Sternschritt

Mit dieser Trainingsübung trainieren Sie Kraft, Beweglichkeit und Gleichgewicht.

Sternschritt: Aus dem Stand mit dem rechten Fuß nach vorne steigen und Gewicht nach vorne verlagern, zur Seite steigen und das Gewicht zur Seite verlagern, nach hinten steigen und das Gewicht nach hinten verlagern, wieder zurücksteigen in die Ausgangsposition. Das Gleiche mit links.



Die Arme dabei entspannt hängen lassen oder mit jedem Schritt nach vorne, zur Seite, oder nach oben heben.

## 3.13. Statt Gemüsegarten

Mit diesem Bewegungsspiel trainieren Sie Kraft, Beweglichkeit, Gleichgewicht, räumliche Orientierung und Reaktionsfähigkeit.

**Spielgerät**: Sie benötigen einen „Ball" – das kann auch ein Wollknäuel, Reissäckchen, Tuch oder Luftballon sein

Den Ball abwechselnd mit Füßen und Händen am Boden antippen, bewegen, hin und her spielen, übersteigen, langsam wegrollen lassen und wieder abfangen.

Finden Sie jene Schwierigkeit und Geschwindigkeit heraus, mit der Sie sich sicher aber auch ein bisschen herausgefordert fühlen – wo es Spaß macht zu spielen.