Create video games to promote well-being of elderly people – a practice-driven guideline

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Abstract. This paper presents a selection of game design concepts to promote social interaction between older people and players from other generations. Hardware-related interaction channels, game mechanics and game content can be used to trigger positive communication between several players. The proposed concepts are based on the experience of 32 game prototypes developed with and for the oldest seniors living in several Swiss nursing and retirement homes. The games are directed at the relatives to make their visits a pleasant and positively perceived experience, with the aim of increasing well-being of all involved.

Keywords: Involving the Elderly in HCI Methodology · Game Design for the Elderly · Technology for the Elderly's Leisure and Entertainment · Intergenerational Gaming · Social Interaction · Increased Well-being

1 Introduction

Computer games are fun and can help to improve well-being of elderly people and their relatives [14]. This is the main motivation of Myosotis. Myosotis is the botanical term for a group of flowers colloquially called forget-me-not. And Myosotis is an umbrella term for several research, development, outreach and application projects in which we create, test and play multiplayer video games for and with elderly people. The games should motivate relatives to visit older people more often, so that the elderly are not forgotten.

The common design rationale of Myosotis is to use games to promote positive social interactions between players of different generations. The games build on the strengths of the elderly and do not pursue medical or therapeutic goals. The sole objective of the games is to entertain and make a visit a pleasant and positively perceived experience, where the visitor can find a new and exciting access to the memories and biography of the aged person [3].

Since 2015 we have implemented over 30 game prototypes. Some of them have been developed as part of a research project, most have been implemented by computer science students in more than 20 case studies. All games have been tested in dozens of applied game sessions in eleven nursing homes in Switzerland. More than 100 people have participated in this process, including researchers, students, therapists, caregivers, relatives, volunteers, children, and most importantly, residents of nursing homes.

All game prototypes are designed for two or more players sitting in the same room around or in front of a tablet computer. We are currently focusing on adults playing with seniors living in a retirement or nursing home. The elderly are usually over 75 years old and face different age-related handicaps. We do not differentiate between mental or physical problems, as in our experience, personal preferences and motivation have a greater influence on which game works best in a given situation. There is certainly not one game that suits everyone.

However, the design of such games is not quite as simple and the design principles to be taken into account are manifold. For this publication we focus on the following two questions:

(1) How can video games promote social interaction and how does this relate to well-being of players?
(2) Which game design concepts for multiplayer video games are most suited to promote social interaction?

The response to the first question is based on the self-determination theory [4, 5] which defines relatedness as one of the basic universal needs necessary for personal well-being. In Myosotis, we use computer games to reinforce this relatedness by actively triggering communication between multiple players. Hereby we distinguish between non-verbal and verbal communication. Non-verbal communication includes physical contact or emotional expressions such as laughter. Verbal communication is divided into game-related and biographical talk. The latter is particularly interesting because it can trigger longer ongoing conversations. When the players start talking about their lives, Myosotis has reached its goal.

To answer our second question on which game design concepts work best to promote social interaction, we reviewed reports, interviews and test protocols of the Myosotis games already implemented and complemented them with our practical experience. As a result, we compiled a list of game design concepts that have proven to be particularly successful in triggering communication between two players.

Section 2 provides the theoretical background of the self-determination theory. Section 3 gives an overview of the Myosotis project to explain the data source for our findings. A summary of the proposed game design concepts can be found in Table 2, and the details are given in Sect. 4. The publication concludes with Sect. 5, which summarizes the work, highlights the limitations, and provides an outlook on further research topics.

2 Theoretical Background

The design rationale of Myosotis is to use video games to improve well-being of elderly people in retirement homes. It is based on the self-determination theory, which provides the psychological foundation to promote well-being [17].

According to self-determination theory [4, 5] three universal psychological needs are relevant for positive motivation, effective functioning and psychological health [5, p. 182]. These basic universal needs are competence, autonomy and relatedness. The self-determination theory assumes that intrinsic motivation to participate in any activity depends on the satisfaction of these basic needs. In turn, activities that satisfy these needs increase energy and can be vitalizing [5].

Empirical results have confirmed that the satisfaction of these basic needs predicts well-being regardless of individual or cultural backgrounds [5]. In other words: If people feel competent, autonomous and related to others, they are intrinsically motivated to perform better and feel comfortable and happy in the long run. If these needs are neglected, people feel less good or even unhappy in the long run.

In Myosotis, we assume that video games can satisfy these basic needs. In this way, they become an intrinsically motivating activity and ultimately can contribute to an increase in well-being. [7] has conducted a controlled study of older people who play video games and found two important results. Playing games was associated with an increase in self-reported well-being and a significant improvement in reaction time.

We claim that playing together with loved ones can satisfy the need for relatedness. This is certainly true during the time of playing and shortly after, but presumably also in the longer term. The need for relatedness encompasses the social dimension of the self-determination theory. A long history of psychological research has shown that positive social interactions are not only beneficial for well-being, but even essential for humans of all ages. Social interaction, social relationships with others and belonging to social groups have been shown to be both protective against depression and curative for an existing depression [2]. Empirical research in media psychology shows that computer-based activities increase psychological well-being and reduce depressive feelings (e.g. [22]). [13] found that "digital games hold the potential to enhance senior's leisure time and social connectedness".

In Myosotis, we look at how video games and specific game mechanics can support positive social interactions. To assess this, we have recently launched a still ongoing study on verbal and non-verbal behavioural indicators of the observed players using video analysis. Verbal interaction is divided into (a) game-related communication, (b) help giving and (c) biography-related communication. As non-verbal indicators we distinguish between (d) laughing together, (e) eye contact and (f) body contact. Well-being is thereby not only understood as the absence of bad feelings, but it is characterized by positive feelings and positive body sensations.

3 The Myosotis Project

The Myosotis project was initiated in 2015 by a very practical issue. While playing computer games with her 90-year-old mother-in-law, games expert Bettina Wegenast discovered that many games did not work. They were too complex, too noisy or simply not designed for adults. She contacted our research group at the FHNW and, together with bachelor students, we started to develop first game prototypes in close cooperation with three Swiss retirement homes. In the following years, several other partners joined the project and two research grants were approved. To date, we have developed 32 game prototypes. Each game prototype addresses a different research question, as shown in Fig. 3 in the Appendix. The project is not yet completed and more games will be developed in 2020.

All Myosotis games are tested in regular game sessions with elderly people. In addition, we frequently organise workshops to gather experience and feedback from other stakeholders such as younger children, relatives, caregivers, therapists and students, to name a few.

Table 1 summarises these activities and the corresponding working hours from October 2015 to December 2019. The data is estimated on the basis of internal reports, log files, bachelor theses and diaries. To date, we can draw on the experience of over 11,000 working hours for development, research and documentation. Of these, more than 500 hours were in direct contact with the elderly. The seniors, in turn, spent more than 800 hours in play with the developers.

Table 1. Estimated work hours for Myosotis games and workshops. The last two columns indicate the person hours elderly people and developers spent together. Further details are provided in Fig. 3 in the Appendix

Project Type	#of games	work hours (dev)	play hours (dev in home)	play hours (elderly)
Student games	18	6,940 h	185 h	293 h
Research games	8	3,500 h	90 h	75 h
Experiments	6	485 h	23 h	28 h
Game sessions	–	100 h	210 h	420 h
Workshops	–	100 h	22 h	18 h
Total	32	11,125 h	530 h	834 h

We believe that this broad experience puts us in an ideal position to iterate and evaluate the game design concepts for promoting social interaction. The fact that all projects followed a common, widely accepted research and development methodology supports the credibility of our results.

3.1 Methodology

The pro-active and early involvement of older people in the design process is crucial to the success of Myosotis and is a key driver for the implemented methodology: a user centred design (UCD) approach complemented by participatory design (PD) methods (also see [12]).

There are several variants of UCD, but, in general, the process is divided into four phases [10, 16, 26]. In phase 1, the context of use is analysed by collecting information about the user group, e.g. through field observations and interviews. In phase 2, requirements are derived from the collected information. These are then implemented in phase 3, in the form of primary design solutions such as prototypes. In the following phase 4, the solutions are tested and discussed with the user group. The resulting findings lead to a further run through the phases until the product meets the user requirements. This iterative approach is one of the three basic principles of the UCD process [8]. The other two are the early involvement of users and the empirical testing of concrete design solutions.

Participatory Design (PD) involves the users directly in the design process, in the sense that they design the product together with the designers [23]. According to [1], direct involvement in the design process aims at increasing the quality of the resulting product. [29] postulates that only through such participation designers can gain a deeper understanding of users' needs. There are various methods of participatory design, such as workshops or cooperative prototyping. The degree of user involvement depends on the field of application and can range from passive observation to active co-decision.

To explain how UCD and PD are used in Myosotis, we now describe the game FoodPlanet, which was developed in 2018 and 2019.

3.2 UCD and PD in FoodPlanet

In FoodPlanet, two players jointly prepare either a Cheese-Fondue or a Hamburger (Fig. 1). The game offers three modes to play. In the creative mode, players freely choose the ingredients for the selected dish. In the cooperative mode, the players prepare the meal as quickly as possible by cooperatively collecting a list of ingredients. In the competitive mode, each player prepares their own meal. The faster player wins the competition. FoodPlanet was tested with over 20 residents from four retirement homes.

In UCD phase 1, the team visited several retirement homes and actively played commercial games with the residents. Through observation and informal discussions, the team established a solid understanding of the needs and challenges of the players. In phase 2, these experiences were consolidated in a short list of requirements.

Phase 3 started with ideation workshops, followed by the implementation of a first prototype. After 6 weeks, this prototype was shown to the elderly and then improved in small iterations. This phase was highly driven by participatory design techniques. Initially, we focused on collecting generic feedback and comments from stakeholders in informal discussions. Then, we presented alternatives of selected features and asked for personal preferences.

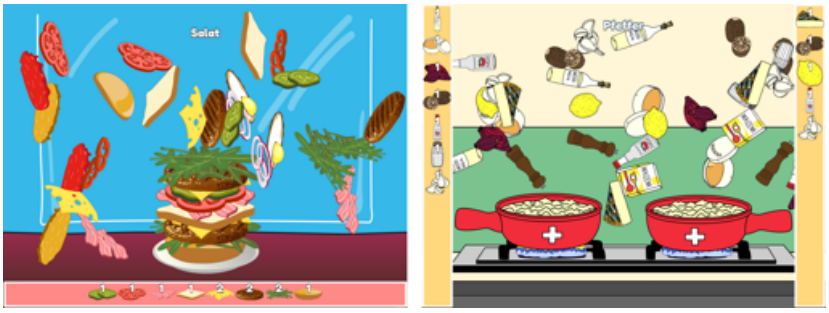


Fig. 1. Creative Hamburger and competitive Fondue preparation

A good practice in this phase is to identify and prioritise those functions that can be implemented at low cost. When participants feel that their comments are being taken seriously, they will eventually become more involved in the design process.

In UCD phase 4, we conducted a psychological field study in a retirement home. We primarily investigated the influence of the three game modes "creative", "cooperative" and "competitive" on the social interaction between the players. A total of 10 residents took part in this exploratory study. Each resident played each game mode with a therapist. The game sessions lasted 20 minutes per mode and were recorded on video to perform an analysis of the social interactions. Although the study has not yet been published, some initial findings are mentioned in the following result sections.

4 Results

To answer our second research question, this paper gives a concrete guideline on how to use different game design concepts to promote social interaction. For this end, we have systematically reviewed reports and protocols of the UCD and PD process from several Myosotis projects and discussed them with stakeholders.

The extracted concepts have been divided into three categories: (1) hardware, (2) game mechanics and (3) game content. Hardware is the physical interface between the game and the real world. It is used to trigger non-verbal communication such as physical contact or movement in space. The game mechanics can motivate players to talk about game-specific topics, e.g. by creating a conflicting situation that requires coordination. Finally, game content can initiate thematic communication, whereby biographical topics are of particular interest. To support the latter, we have integrated personal media such as photos, video or audio into some of the games.

Table 2 provides an overview of these concepts and lists our results and suggestions. The subsequent sections iterate further details on each topic and refer to publications by other research teams. We also indicate the number of

Myosotis games used to validate a particular concept. Where appropriate, we expand the descriptions with exemplary Myosotis games.

4.1 (1) Hardware Channels to Promote Interaction

A tablet computer provides multiple input and output channels for interaction. In Myosotis, we used four of them to achieve our goals: multitouch screen, microphone/speaker, orientation and position sensors and camera.

(1a) Multitouch Screen A multitouch screen is the most direct and intuitive input channel for the elderly. It makes less demands on hand-eye coordination and the spatial movements of the user [28] than other technologies such as a mouse or game controller. Even complex touch gestures like dragging or pinching can be learned quickly [11].

A shared touch screen area triggers game-related communication when used by multiple players simultaneously [21]. Whether the area is used for interaction or just for display it will provoke a conflict that requires coordination. A split screen can also work, but the interaction between players would have to be enforced by the game's mechanic and not the hardware. In Myosotis, 17 of the games use a shared screen area, while only three use a split screen. The rest are either turn-based multiplayer or single player games.

When designing games for older people, only direct touch input should be used. All experiments with indirect touch control (e.g. when a virtual joystick controls a character) were abandoned during the UCD process. They were just not user friendly.

1b) Microphone and Speaker Voice or sound controlled games with audio feedback can work for people with severe visual impairments but still good hearing abilities. In Myosotis, we have recently begun to gain initial experience with two sound driven games [15]. In "Los Emol" ("Listen!"), one player uses headphones to listen to sounds while the other person controls the screen. The game is characterised by a high mutual interdependency. Only by talking to each other, they can solve the audio puzzle (Fig. 2a). To our knowledge, no research has been done in this field so far and we see some potential for further work.

(1c) Orientation and Position Sensors The orientation and position sensors of a tablet (i.e. the gyroscope, accelerometer and magnetometer) allow the measurement of the tilt of a tablet. [25] discuss games where tilt input is more natural than the other options. However, tilt interaction with large tablets can also cause fatigue because the device must be held in the air.

For Myosotis, we have implemented five collaborative tilt controlled games. Two players hold the tablet with four hands so that each thumb touches a corner of the screen. Together, and in close coordination, players must catch moving objects or solve a puzzle. This leads to game-related communication: "Do you want to take the purple or the brown dot?".

Table 2. Summary of game design concepts and suggestions to promote social interaction through video games

Category	Concept	Techniques and suggestions
(1) Hardware	(1a) Multitouch Screen	Sharing a screen area leads to conflicting situations, which require interpersonal communication.
	(1b) Microphone and Speaker	Helpful for people with visual impairments. Audio output can add an extra channel on top of visual output.
	(1c) Orientation and Position Sensor	Tilting a tablet which is held by two players creates an enjoyable multiplayer experience.
	(1d) Camera	Many people refuse or dislike to be taken pictures of. To those who agree, however, camera driven games are entertaining and fun.
(2) Mechanics	(2a) Toy or Game	Toys are better suited for people with mental impairments as well as to introduce new technology to non-gamers. Games are better for other people. To promote social interaction, both are equally well suited.
	(2b) Single Player Games	Single player games are fun to be played together, side by side. Best suited are animated toys and puzzle games.
	(2c) Cooperative Play	Cooperative play triggers more game-related communication than competitive play. Asynchronous games, where players play a different role or task, are a very promising cooperative variant for elderly.
	(2d) Bi- and Multilateral Competition	Direct competition should be avoided. Indirect, non-simultaneous competition between a group of personally known players, however, is very motivating.
(3) Story Content	(3a) Storytelling	Stories should be short; animated books work best.
	(3b) Emotionally Charged Game Elements	Game elements a user can emotionally engage with lead to discussions and, therefore, to interactions between the players.
	(3c) Personalised Media	If photos, videos, audio tracks and texts from the personal environment of a player are embedded in a game, they will trigger communication. The media can be used as a visual design element, as a reward or as part of the core mechanic.

(1d) Camera We use the camera in two ways for collaborative play: the front camera for live portraits and the rear camera for augmented reality. In both cases our experiences are ambiguous.

For live portraits, we did not implement any games, but rely on existing apps like FaceApp, YouCam Makeup or Chomp, which modify a live image of the player's face in the game. Using the camera in this way is highly individual. Some people enjoy to see and play with their portrait, but many turn away as soon as they see themselves. Interestingly, we have had some of the most enjoyable and memorable two-player gaming sessions with camera-controlled games. It is not clear, however, whether this is because of the games or because the players were simply more extroverted and humorous.

The use of Augmented Reality (AR) on a tablet device is not suitable for elderly. In AR games, a live image taken by the rear camera is supplemented by digital objects. We have tested several AR games and even implemented one by ourselves, but with little success. The players were confused by the digital objects and were overstrained by the coordinative tasks required to control the game. Observing the screen, moving around in a room and simultaneously solving a task is too demanding and leads to frustrating experiences. Therefore we did not investigate further in this direction.

4.2 (2) Game Mechanics to Promote Interaction

Many game mechanics can be customized to promote social interaction, and it would go beyond the scope of this document to list all of them. Instead, we focus on the involved player interaction patterns and, first, on the discussion whether a toy or game is better suited to foster positive social interaction.

(2a) Toy or Game The distinction between game and toy is controversial [30]. In general, a toy is an object with which you can play as freely and as long as you want. A game specifies goals, rules, restrictions and a final state. [20] condenses a comprehensive discussion on this topic in the statement: "A game is a problem-solving activity, approached with a playful attitude". [18, Chap. 9] says "With a toy, it may be difficult to say exactly when the play begins and ends. But with a game, the activity is richly formalized. The game has a beginning, a middle, and a quantifiable outcome at the end. The game takes place in a precisely defined physical and temporal space of play."

For Myosotis, we have implemented 12 toys and 20 games. The toys seem to be preferred by people with mental disabilities — as long as they are easy to use, entertaining and surprising. Toys do not promote vocal communication per se, but rather through their content.

We often use toys to break the ice when starting a game session with elderly. With a toy, there is no evaluation of a players' actions, there is no right or wrong. Therefore, they are ideal for familiarising oneself with the devices and avoiding exposure of individual impairments. Nevertheless, toys can quickly lose their appeal due to the lack of a challenge or goal. Many players seek a challenge

and a purpose. We often meet players, an a majority seems to be male players, who leave the game session because they do not see the purpose.

A toy can be interrupted and resumed at any time. This is more difficult to achieve in a game, but in our experience it is crucial to provide this functionality because the players need the freedom to start a conversation at any time. This implies that time-dependent games are rather unsuitable for the purpose of social interaction. If time-pressure is used, games should be short and goals should be reachable quickly.

(2b) Single Player Games [6] lists seven common player interaction patterns. Four of them were used in our games: Single player vs. game (six games), cooperative or collaborative play (19 games), bilateral competition (player vs. player, four games) and multilateral competition (all vs. all, five games).

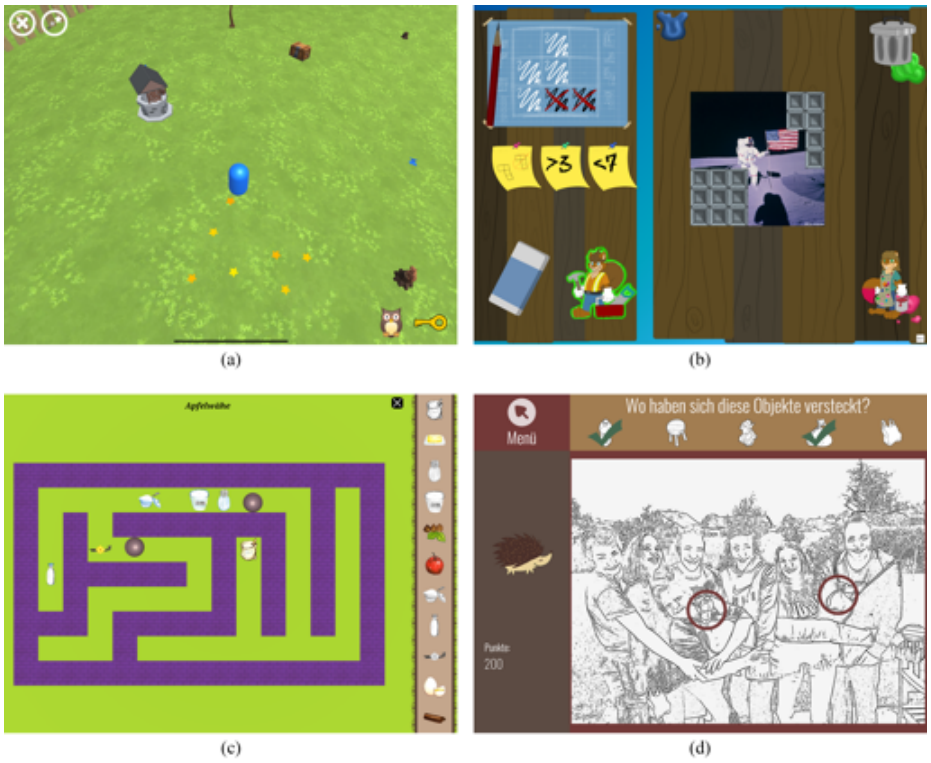
Many single player games can be played together, side by side. One person takes the role of the active player, the other is the advisor. Single-player games do not force interaction per se, but the game environment, the fact that two players participate, makes them a "multiplayer" experience. Puzzle games and animated toys are particularly suitable for this.

(2c) Cooperative Play In cooperative games, two or more players play together to beat the game [6] or to play with a toy. The development of such local co-op games and in particular toys is a key concept of Myosotis. Indeed, 11 of the 12 implemented toys are cooperative. We believe that multiplayer toys are ideal to establish communication as they leave enough time to start a discussion at any time.

The aforementioned FoodPlanet study supports our assumptions. The creative mode is comparable to a multiplayer toy. Players can freely cook their food and take as much time as they want. First results from the study show that in the creative mode 56% of the overall playtime is related to social interaction as opposed to 47% in the competitive mode and 43% in the collaborative mode under time pressure.

Asynchronous Play An interesting variant of cooperative games are asynchronous multiplayer games in which the players have different roles. In "Puzzlitekt", two players have to reveal an image covered by a grid of tiles (Fig. 2b). The first player is an architect and constructs Tetris-like pieces. The second player is a painter and searches for free spots to place the pieces on the grid, in order to remove the tiles and find the underlying picture.

(2d) Bi- and Multilateral Competition [13,19] have found that older adults cite diversion and social interaction as the main motivating factors for playing games. Challenge is somewhere in the middle and arousal, competition and fantasy are at the bottom. While this is largely consistent with our observations, we found that competition should be discussed in more detail.



(a) (b) (c) (d)

Fig. 2. Screenshots of selected Myosotis games: (a) "Los Emol" ("Listen!") is an asynchronous audio game; player one sees the screen; player two only hears the audio (b) "Puzzlitekt" is an asynchronous puzzle game; left is the playground of the architect; right the one of the painter. (c) In "Was git's z'Ässe?" ("What's for dinner?"), two players collect the ingredients of a meal. (d) In "HiddenObjects", small graphical objects are hidden in an personal image.

Like [28], we also observed that the players enjoyed the indirect competition against other teams. In the FoodPlanet study, we found that beating the high scores of the retirement home was motivation enough to keep trying. A therapist later reported several discussions about who held the record, in the days following the play session.

We noticed that indirect competition only seems to work if the other competitors on the highscore list are known to the player. In games with a global highscore, players never showed interest in beating it or even looking at it.

It is important to avoid a direct one-to-one competition between generations. Elderly people are more likely to become aware of their age-related weaknesses. They also repeatedly expressed their discomfort when younger players let them win: "Don't let me win! I am not a child".

4.3 (3) Game Content to Promote Interaction

When it comes to biographical communication, the content, topic or story of a game is a key factor. Three core concepts that are helpful for social interaction were identified in our games: storytelling, emotionally charged game elements and personalised media. The concepts are ordered by the increasing degree of individualisation they offer to a game designer.

(3a) Storytelling In storytelling games, the communication topics are usually influenced by the story itself. Due to the high amount of work involved in developing such games and the limited replayability, we have only experimented with commercial story games. We have made the best experience with short animated books. Longer stories do not seem to appeal to elderly anymore. At all game afternoons since 2015, we only met one woman who was eager to continue a story game from the last session.

(3b) Emotionally Charged Game Elements Reminiscence work is a form of therapy based on life experiences, memories and stories from the past [27]. Instead of asking questions, people are presented with objects, photos, songs or poems that are connected to their memories. As game designers, we use this method by adding emotionally charged elements to the games. There is no consensus on common topics for such elements, but literature shows different categories that seem to work for many people: holidays, "firsts" like the first car or toy, work and home, sports, animals and food [24].

In Myosotis, we experimented with four games that use cooking ingredients as a topic. In our maze game "Was git's z'Ässe?" ("What's for dinner?"), two players collect ingredients for typical Swiss meals (Fig. 2c). Besides "FoodPlanet", our other food game, this is one of the most played Myosotis games. And it works: "I never put raisins in my Muesli, my husband didn't like them", a woman said one day and then continued talking about her husband, her wedding and her family. The game was put aside and her story was put in the foreground.

(3c) Personalised Media To a large extent, the reminiscence work is based on biographical material, such as personal pictures and objects. Driven by this knowledge, we have developed 13 games that include personal media such as photos, video, audio and personal text snippets. In the games, the media can be used in three different ways: as game mechanics, as rewards and as a visual design element.

Media as Game Mechanic The use of media as game mechanic places the media at the game's core. A personalised Memory or jigsaw puzzle are simple examples for such game mechanics. But digital jigsaws are not optimal for multiple players and Memory depends on short-term memory, which is not a strength of aged people. In Myosotis, we have implemented five games that use more sophisticated forms of such mechanics.

The most notable Myosotis game is "Hidden Objects". A personal image is algorithmically modified, and small objects are automatically hidden in the image. The players have to recognise the objects (Fig. 2d).

Media as Reward Media can serve as a reward for a completed level or as a collectible within a game. One of Myosotis' early observations was associated with a famous Swiss dice board game called "Eile mit Weile" ("Haste with time"). Two students created a digital version of the game and added additional fields showing personal photos. As the game proved to be too complex for most players, they spontaneously changed the rules. Instead of trying to get all meeples to the goal area, the new motivation to play was to uncover as many pictures as possible.

Media as Visual Design Element As a visual design element, personal media can be placed in a game world or used, for example, to personalise an avatar. This area has not yet been investigated by Myosotis, but will be further examined in one of the next Myosotis games.

5 Conclusions and Further Research Topics

In this publication we provide answers to the following questions:

(1) How can video games promote social interaction and how does this relate to well-being of players?
(2) Which game design concepts for multiplayer video games are most suited to promote social interaction?

Question (1) is answered by self-determination theory, which defines relatedness to important others as one of the basic universal needs necessary for personal well-being. Video games can reinforce this relatedness, by using various game design concepts to promote interaction between players from different generations. These games lead to positively perceived, shared experiences and

ideally motivate relatives to visit their elderly loved ones more often. Ultimately, this improves the well-being of everyone.

The answer to question (2) is given by the result section of this paper, namely the list of game concepts which are suitable to promote social interaction between multiple players. From over 30 games developed for the Myosotis project, we have extracted the concepts that trigger communication, whether verbal or non-verbal. The concepts are divided into three categories. Hardware related interaction patterns, a selection of game mechanics and the content or story of a game. In particular, the content of a game can establish conversations with a longer duration.

We have also shown that the types of games preferred by different players are highly individual. The players have to agree on a game they like and which is accessible to everyone. Ideally, games for elderly can be played in multiple ways and support both toy-like, creative modes as well as game-like, goal-oriented modes. In either case, it is important to be able to interrupt and resume the game without any disadvantages. Once the players have agreed on a game, playing together is a fun and entertaining social activity, not only for the active players but also for spectators.

This list of game design concepts is by far not exhaustive. Myosotis focuses on the development of touch-based, local multiplayer video games and has not considered other technologies or interaction patterns such as game consoles or playing over a network.

Also, we did not address visual aspects of video games for elderly people. While usability for older people is treated quite well in literature [9], there seems to be a lack of knowledge in the domain of art style and aesthetics. However, we expect that aesthetics and certain usability related facets have a significant impact on social interaction. This is an important field that needs more investigation.

And finally, another important question remains unanswered. How can we compare the effects of the proposed design principles on social interaction and how can we assess the subsequent well-being? In a next step we plan to extend our study to better understand how personalised media in games stimulate communication and what impact this has on social well-being compared to non-personalised games. This will include the development of a method to assess well-being of elderly people.

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7 Appendix 1: List of Developed Games

Game	Year	Project	Description	Toy/Game	Media as Game Mechani	Media as Reward	Media as Design Element	Single Player vs Pame	Player vs Player	Cooperative Play	Competition	Asynchronous Coop	Turn-based	Split Screen	Shared Area	Direct Touch	Indirect Touch	Tilt	# Person Visits (Dev)	# Person Visits (Elderly)	# Person Hours (Dev)	# Person Hours (Elderly)	Work Hours (Dev)
Eile mit Weile	2016	Bachelor	Personalizable "Eile mit Weile"-Game, in which personal pictures, sounds and texts appear during the course of the game.	Game		x					x		x			x			9	4	14	6	360
Hide and Seek	2017	Experiment	Icons are manually hidden and then searched in a personal image.	Game	x				x				x			x			0	0	0	0	80
KitchenTable	2015	Bachelor	A table with crockery and cutlery, which can be arranged as desired.	Toy						x					x	x			6	3	9	4.5	20
MyosotisVillage	2017	Bachelor	Game portal. Games are hidden in houses in a village. The houses can be reached by car via roads.	Toy		x				x						x			9	13	15	16	720
ColourBubbles	2017	Bachelor	Mix two colours such that new target colors are created.	Game					x						x	x			2	2	1	1	120
Mystix	2018	Experiment	The players light up a dark surface with fireflies to uncover personal images.	Game		x					x				x	x			1	2	1	2	200
Piano	2016	Experiment	Two sided piano	Toy						x				x		x			4	4	2	2	40
Putzspiel	2017	Experiment	Clean a dusty personal picture by wiping away the dirt.	Toy		x				x					x	x					10	12	120
MusicPong	2016	Bachelor	Two players create musical notes and instruments. Sounds are played when they meet.	Toy						x					x	x			6	8.5	4	7	180
Sternenspiel	2016	Bachelor	Collect stars and interact with planets to produce different sound and graphics effects.	Toy						x					x	x			6	8.5	4	7	180
Verzogene Welt	2017	Bachelor	A personal image is projected onto a virtual rubber skin, which then can be distorted.	Toy	x					x				x		x			7	20	7	20	360
TonSpur	2018	Experiment	Experimental game for sound and graphics effects.	Toy						x					x	x					10	12	40
Familienspaziergang	2016	Bachelor	In this digital board game two players search for object and receive personal pictures as a reward.	Game		x					x		x			x			14	13	14	13	360
Was gits z'Ässe?	2016	Bachelor	In a maze two players jointly collect ingredients for a meal.	Toy						x					x	x			12	24	18	36	1000
HiddenObjects	2018	Bachelor	A photo gets transformed to a black and white line drawing. Graphical objects are then placed in the drawing and have to be found.	Game	x					x					x	x			6	6	8.5	8.5	720
MoviePuzzle	2018	Bachelor	Several film snippets must be put in the correct order.	Game	x			x								x			6	9	6	9	360
MovingSouvenirs	2018	Bachelor	Two to four players collect given objects. The player who has found 10 objects wins.	Game							x				x	x			9	19	11	24	360
Wimmelbild-Designer	2018	Bachelor	Cutout pictures of famous people can be placed in an arbitrary scene	Toy	x					x						x			4	14	4	14	180
PuzzliTekt	2019	Bachelor	Asynchronous Puzzle-Game for two players, simultanious or turn based.	Game		x				x		x		x		x			16	28	34	57	360

Fig. 3. List of games developed for Myosotis (1/2)

Game	Year	Project	Description	Toy/Game	Media as Game Mechani	Media as Reward	Media as Design Element	Single Player vs Pame	Player vs Player	Cooperative Play	Competition	Asynchronous Coop	Turn-based	Split Screen	Shared Area	Direct Touch	Indirect Touch	Tilt	# Person Visits (Dev)	# Person Visits (Elderly)	# Person Hours (Dev)	# Person Hours (Elderly)	Work Hours (Dev)
MyosotisMuseum	2018	Bachelor	Studies about orientation of elderly people in virtual rooms	Toy		x		x								x			17	17	14	15	720
CouchPotato	2019	Bachelor	Augmented Reality game in which the player has to grow plants.	Game				x									x		9	10	9	10	360
ShapeMatch	2019	Bachelor	Recognize touches of multiple players.	Game					x						x	x			6	22	6.7	24	220
SoundGame	2019	Bachelor	Use a xylophon as input device for a sound game.	Game				x								x			9	25	7.3	21	360
Colordy	2019	Research	By tilting the tablet two players roll a sphere over a coloured checker board,	Game						x								x			3	3	240
Los Emol	2019	Research	Two players have to find hidden animals by following their noises.	Game						x		x			x	x					3	6	240
Marbelenture	2019	Research	Maze controlled by tilt.	Game						x						x		x			0	0	240
Dandelion	2019	Research	Two players controll a dandelion flower on its descent by tilting and avoiding harmful objects.	Game						x					x			x			3	3	240
Navigest	2019	Research	Research game to test different navigation types.	Toy						x					x	x	x	x			10	12	360
FoodPlanet	2018	Research	Two players have to cook a fondue by catching flying ingredients and throwing them in the pot.	Game					x	x					x	x					61	39	1000
The Reunion	2019	Research	Game collection which consists of the five slightly adapted game concepts: Colordy, LosEmol, Marbelenture, Dandelion and Navigest.	Game				x								x		x			10	12	1000
Moving Souvenirs II	2019	Research	Re-implemenetation of Moving Souvenirs	Game							x				x	x			0	0	0	0	180
Hüpfball	2019	Experiment	A puzzle in which a bouncing ball is used to uncover and cover plates underneath. Revealed plates show part of a personal picture.	Game		x				x					x			x					5
Games: 32				**12 / 20**	**5**	**8**	**0**	**5**	**4**	**19**	**5**	**2**	**3**	**3**	**17**	**28**	**2**	**6**	**158**	**252**	**298**	**396**	**10925**

Fig. 4. List of games developed for Myosotis (2/2)