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LONG PAPER

Designing for collaboration: a study in intergenerational social game design

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Abstract This paper presents a study of a computer game designed for the elderly, allowing them to train their memory while playing the game. The game supports both a single-player and a multiplayer mode, in which the elderly can play with their friends or family using an embedded video chat application. The main question that is addressed in this paper is how the elderly gamers' experience is influenced by the possibility to communicate directly with the other players. The study presents a comparison of the game experience and appreciation of older users and their (grand)children playing the game together, with or without the video chat application. Most importantly, the study shows that the added value of video chat is not limited to social contact, but that it also provides opportunities for the younger generation to assist the elderly during the game. In conclusion, the paper points out some intergenerational game design implications, and some future research suggestions.

Keywords Intergenerational communication · Elderly · Game design · Game evaluation

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1 Introduction

1.1 Gaming, communication, and the elderly

Gaming is an increasingly popular entertainment medium. Whereas the "traditional" gaming target group consisted mainly of young males [5], an increasing variety of demographic groups are successfully targeted by the gaming industry, and are addressed in gaming research. For instance, studies in female gaming [24] and game design for the elderly [14] have been conducted, taking into account specific gender-related issues and age-related design issues. Moreover, more recent research also investigated how different demographic groups can be brought together through gaming, for instance in intergenerational gaming [16, 26]. This paper aims to contribute to this intergenerational gaming research in exploring how direct video communication between older and younger players in an intergenerational game influences game experience.

1.2 Related work

Game design for the elderly has been studied quite intensively [3, 10, 14, 20, 25, 28, 30] (see also [12] for evidence on the potential beneficial therapeutic effects for the elderly), as have intergenerational aspects in communication [1, 7, 17], (see [18] for a review of relevant literature in human-computer interaction (HCI), human factors, and gerontology). Specifically related to the subject of this paper, (asynchronous) intergenerational video communication has been studied in [13], discussing a case study of an elderly video blogger. The paper suggests that social interaction is an important motivation for technology use by the elderly.

Adding the intergenerational aspect to the gaming picture, studies in intergenerational gaming have been

conducted less frequently, and mostly have focused specifically on family relationships, such as the (grand)parent–(grand)child relation [16, 26]. Building upon some of these topics researched in literature, this study aims to combine the intergenerational video communication aspect with gaming.

1.3 The TranseCare project

The TranseCare project is a 3-year Flemish research project (2007–2010) focusing on elderly people suffering from a chronic or degenerative illness as a result of the aging process. It is a joint effort of a number of Flemish academic research groups and industrial partners, aimed at setting up a communication network to enable the elderly to communicate with medical staff, caretakers, their family and friends. The purpose of the project as a whole is to place the elderly at the center of a communication network, allowing them to contact their social network from the comfort of their homes. The network contains separate applications that can be combined in a modular way, to make up an integrated communication network. This makes for a network that can be configured to fit the user's needs as closely as possible. The applications in the network include a medical alert system, a secure exchange system for medical documents, a video chat application, online multiplayer gaming with video chat functionality, and a photo sharing application. Together, these applications form a scalable platform empowering the elderly to communicate with their social network [2]. While the individual applications have been extensively tested in a laboratory setting, (parts of) the communication network have been installed in the homes/retirement home rooms of four elderly, plus one in a public space (a "cyber café" in a home for the elderly) for 4 months, in an extensive field trial.

1.4 Gaming in the TranseCare platform

One of the entertainment-focused applications in the communications platform is an online single or multiplayer game, which is designed as a "brain training game".

For this game, preliminary, exploratory observations have been conducted. Older people have been observed while playing games in a community center and a day care center for the elderly. These observations showed that older users value the social contact in playing games more than the actual outcome of the game (i.e., winning or losing). For instance, it was observed that older people played multiplayer games for the sake of the game itself, without bothering to keep scores of the individual players. Comparable observations about the importance of social contact have already been made by several authors, such as O'Connell, discussing social connectivity mediated by computers [22] and Vanden Abeele [25], describing an emphasis on social connectedness in game design by the elderly.

The TranseCare brain training game is somewhat comparable to several existing games made available by both bigger and smaller game manufacturers, such as Nintendo (Dr. Kawashima's Brain Training) [21] and LunaNL BV (www.neurocampus.nl) [19]. Although there is some skepticism about the effectiveness of such games [4, 9, 11], the primary focus of the TranseCare game was to offer a fun way to connect the elderly and their family and friends. To stimulate this social aspect, the TranseCare game offers the elderly the possibility to play the game *collaboratively* with their relatives and friends in multiplayer mode via video chat, whereas many of the available games have a single-player or a competitive multiplayer design. This video chat functionality has been added to create a richer, more personal and social gaming experience.

1.5 The TranseCare shopping game

The game in the TranseCare platform can be described as a "shopping game", in which the players have to memorize items on a common shopping list. During the game, the players can talk to each other using screen-mounted webcams. In the first stage, players see a shopping list with a number of groceries (identical for all players) which they have to memorize, and buy in the shop afterward. After looking at the shopping list, they enter the store, and they buy those items that were on the shopping list, putting them in their shopping carts (see Fig. 1). While doing this, participants can see the content of their own and of each other's shopping carts. They can also discuss the progress of the game using video chat, for instance, to divide work: e.g., which player will remember and buy which groceries. During shopping, however, the players cannot "return" to the shopping list to check their purchases.

After the shopping phase, players move on to pay for the items they have bought. In this final phase of the game, the players get feedback on their performance: the initial grocery list is compared to the items that were actually bought, and the players get a final score based on the items that were bought correctly or not (correct items: +1 point, wrong or forgotten items: −1 point).

2 Method

The test design of the shopping game focused explicitly on the user experience of the game with or without the video chat functionality. For the evaluation of the game, 15 couples of one elder (60 or older, average age 68), and

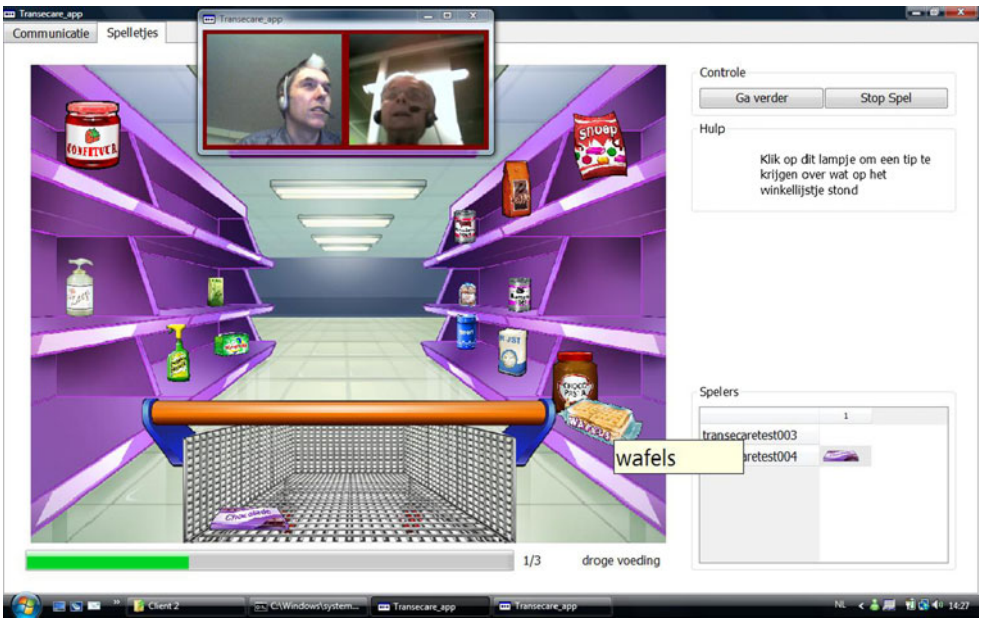

Fig. 1 Shopping game interface

his/her (grand)child (15 or older, average age 22) participated in the test. There were 6 male and 9 female older players, and 5 male and 10 female younger players. The participants were placed in separate rooms, playing the game twice in multiplayer mode, alternately with (condition A) and without video chat (condition B). Seven couples started out with the video chat game (condition A first), while eight couples first played the game without video chat (condition B first). As each participant couple completed both conditions, this made for a within-subjects test design with two test conditions.

In condition A, both participants played the game, trying to remember and buy the items from the same grocery list. Participants could at all times see the content of each other's shopping cart. The video chat functionality added to the game allowed the participants to discuss which items to buy, and which not to buy. In condition B, both participants also tried to remember and buy the items from the same grocery list. They could also see the content of each other's shopping cart. However, the lack of video chat prevented discussion about which items to buy.

The test design, alternating the order of the games with and without video chat, attempted to determine the effect of the order in which the games were played. This made sure that the interpretation of the test results was not biased by a limited viewpoint as a result of a test design that only accounts for one specific game order. Testing only one specific order would, for instance, give no information on the learning curve of the game, and on the effects that the learning curve has on communication during the game. Testing and comparing the two game orders allowed for a more nuanced test result interpretation concerning such effects.

All game sessions were videotaped for analysis purposes. After completing the games, participants were asked to fill out a questionnaire with questions about their own subjective idea of their performance in the game and how pleasant they thought the game was.

2.1 Analysis

The videos of the game sessions with video chat were analyzed by timing all conversations between players, and by tagging all utterances according to the topic of the conversation. Non-verbal communication was registered separately, but not tagged. Tagging conversations and test user utterances is a known practice in HCI. For instance, De Souza [6, 23] and the Semiotic Engineering Research Group (SERG) have been using tagging in "communicability analyses" to trace communicative breakdowns during interaction, categorizing observable user utterances and interactions. Also, Ducheneaut [8] and Weisz [27] have used conversation tagging in the context of interactive television chat applications.

The tagging typology used in the analysis of the shopping game starts from the general framework of language functions by the linguist Roman Jakobson [15] (see Fig. 2, main blocks). This framework has been "enriched" with the typologies of Ducheneaut and Weisz. Based on the resulting framework, the categories relevant for the shopping game typology have been used for tagging.

The tagging framework used in this study contains the following types of communication.

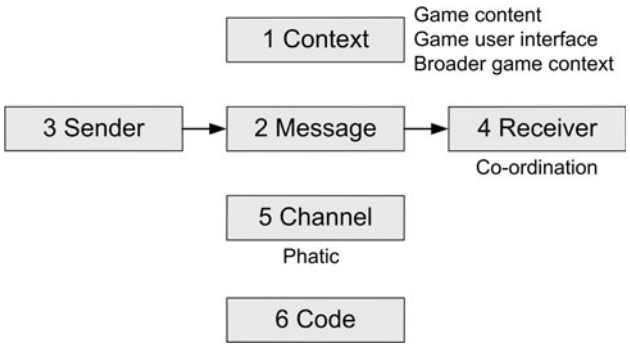

Fig. 2 Jakobson's communication framework filled in with categories relevant for the shopping game study

- "Game content" refers to communication about the actual content of the game: e.g., which items to remember, and which items to buy in the shop.
- "Game user interface" refers to communication about the user interface of the game, e.g., the younger player telling the older player which buttons to click, and what to do to advance the game.
- "Broader game context" refers to communication about elements from the participant's lives and environment, related to the game. e.g., one player saying to the other: "Normally, you're quite good at shopping, aren't you?"
- "Coordination" refers to the players' coordinating their movement through the stages of the game. For instance, test users typically told or asked each other to move on to the next game stage together, e.g. "Let's move on to the pay desk."
- "Phatic" communication refers to communication with no other goal than to establish or maintain contact. Typical utterances can be "Hello", "Can you hear me?", etc.
- "Miscellaneous" refers to a small rest category of communication that could not be fitted in the above typology.

3 Results and discussion

3.1 Conversation tagging results

3.1.1 Content chat and coordination

The inherent difference between the test conditions (condition A with video chat, condition B without) created a rather different game experience for the test participants. In condition A, both participants tried to remember and buy the items from the same grocery list. The video chat functionality added to the game allowed the participants to *collaborate* and discuss which items to buy, and which not to buy. In condition B, both participants also tried to remember and buy the items from the same grocery list. However, the lack of video chat *prevented* collaboration and discussion about which items to buy.

Therefore, condition B was the more *competitive* condition, in which the participants could compare the number of items they bought correctly with the other participant's performance. This condition combined memory skills with speed, as only one participant could buy a particular item in the grocery store.

In the conversation analysis graph (Fig. 4), the collaborative aspect of condition A is apparent. The figure shows that in the games with video chat most conversation time (64%) indeed was spent talking about the game content: which groceries to buy in the shop, and (closely related) coordinating which player should remember and buy which items from the grocery list. Although both participants could navigate the game freely and independently, most participants naturally chose to navigate through the separate game stages together ("Shall we move on to the pay desk now?"). These conversations generally allowed participants to talk, collaborate, and negotiate about the game strategy. Only one younger test participant couldn't really help her father (without any prior computer experience) in understanding and playing the game.

3.1.2 User interface chat

On average, 30–60% of gaming time in game condition A was used for conversation (not counting the "silent" test group 7 that didn't communicate at all, or test group 5 that communicated more than 70% of gaming time, see Fig. 3). Figure 3, with conversation percentages in test condition A, shows that test users who played the game in condition A (with video chat) in their first encounter with the game, didn't talk much more (44% of the time on average) than the test users who first played the game in condition B (without video chat), and used video chat only the second time they played (conversation during 37% of the time during that second game). The order in which the games were played therefore only has a small effect on the amount of conversation in test condition A.

Comparing Figs. 3 and 4, it can be observed that the games in which the players spent the highest percentage of the game talking (participant groups 5 and 6, 72 and 61%) were also the games in which a very large part of the conversation time was used to talk about the game user interface. This suggests that high conversation percentages often indicate that more time has been spent discussing the game interface, instead of discussing the game content itself.

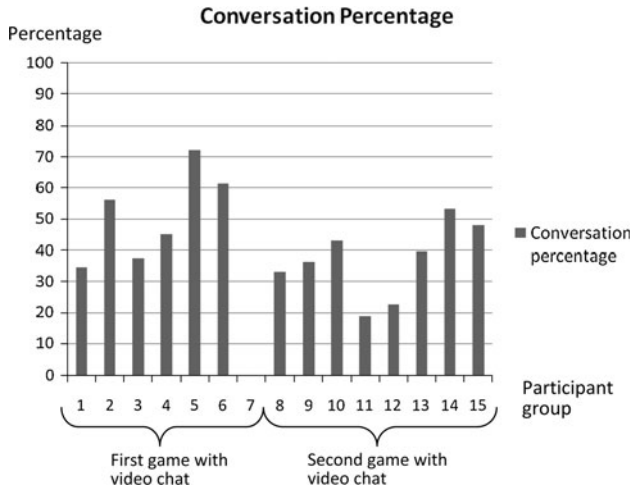

Fig. 3 Percentage of time used for communication in test condition A (video chat game)

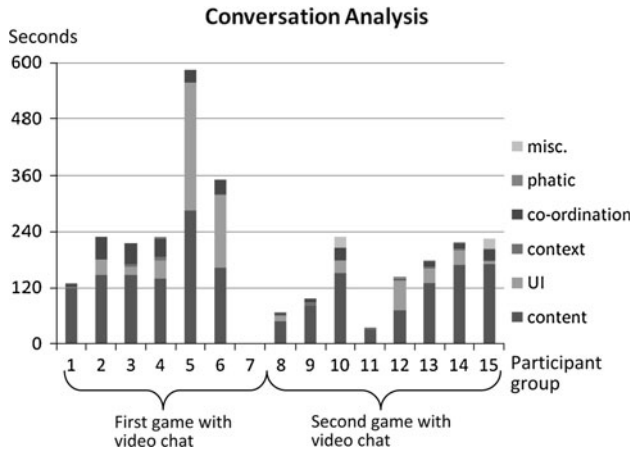

Fig. 4 Analysis of conversations during condition A (video chat game)

In addition, comparison of Figs. 3 and 4 show that participant groups 5 and 6, the two groups with the highest conversation percentages and much talk on the user interface of the game, played the game in condition A (with video chat) in their first encounter with the game. This leads to the observation that the peaks in the graph for groups 5 and 6 are very likely due to the player's unacquaintedness with the game. If these groups had had more experience playing the game, for instance if they had played condition A (with video chat) the second time, discussions on the user interface would have been less dominating in Fig. 4, thereby reducing the overall discussion percentage in Fig. 3. In other words, the order in which the games were played, and the resulting learning curve, can offer an explanation for the peaks in overall conversation time.

In the games with video chat, (grand)children were generally quite successful in guiding their older relatives through the game interface: nearly everyone managed to complete the game successfully. If necessary, they told their (grand)parents what to do next, which buttons to click and where to find them. However, one problem occurred. One of the younger participants, seeing her father struggle with the user interface, told her father: "*You have to click HERE!*", pointing her own mouse cursor at the right button. This is an inappropriate use of context-dependent words. The daughter, seeing her father on screen and knowing that he could see her, spoke as if her father could also see her actions on screen. Although she was aware of this and repeatedly corrected herself, the presence of the webcam seemed to make her think that her father could see more than only the webcam image.

3.1.3 Context chat

Although the test participants were close relatives, chat discussions were rather strictly limited to game-related content. Very little time (1% of total conversation time) was spent on talking about more personal topics. If it did occur, comments were always still marginally related to the game and mostly made jokingly, for instance one mother saying to her son: "*Normally, you're quite good at shopping, aren't you?*" Other digressions haven't been observed during the game sessions.

3.2 Non-verbal communication

As screen-mounted webcams were used for video chat, it was to be expected that most communication between players was purely verbal. However, two kinds of non-verbal communication were observed. These communications were not tagged, as they occurred rather infrequently (only 5 times in 15 games). In one instance, a son had to show his mother how to put the microphone on her headphones closer to her mouth, telling and showing her what to do. This way, he made maximal use of the video chat possibilities, combining verbal and non-verbal communication.

As for the other non-verbal communication, four couples waved at each other, laughing, when they first saw each other on camera. This mode of communication is very closely related to the communication that would be tagged as "phatic", as it is a way of greeting and establishing contact with the other player. Mostly, the elder participant waved at the younger one, always without saying a word. Interestingly, with this behavior, players check whether the other participant also sees the video image, without using the same medium to speak up—verbalized greetings and discussions were generally initiated by the younger participant. This could indicate an initial reluctance on the part

of the elderly to initiate verbal communication, as a kind of electronic communication anxiety.

3.3 Participant's game evaluations

3.3.1 Video chat versus no communication

After playing the games, participants were asked in the post-test questionnaire whether they liked the game they just played, and which version they preferred (with or without video chat). About 60% of the elderly clearly preferred the game with video chat, while 40% thought the games were equally fun. Of the younger participants, 80% of the participants liked the game with video chat more, and only 20% thought the games were equally fun. Several sources describe that the elderly tend to value especially the social contact involved in playing games ([22, 25], own observations). The results in the shopping game experiment suggest that the younger generation also highly values direct social contact via video communication, while it was expected that the younger generation is more acquainted with other media for keeping in touch, such as text chat and SMS. However, comparison with the participants' backgrounds suggested an important interfering factor in these results. Of the elder participants valuing the video chat game equally or less fun than the game without chat, 4 out of 6 participants reported only very limited, or even no previous computer usage. Therefore, reluctance to use unfamiliar communication methods may be an important issue here—the non-verbal greeting behavior being one of the possible expressions of this. One of the test participants illustrated this point by explicitly commenting in his post-test questionnaire that he "wasn't knowledgeable" about computers and computer games. The reluctance to speak up and use unfamiliar communication methods can be further illustrated by the fact that in at least two thirds of the games played, it was the younger participant initiating the conversations, and generally taking the lead in the navigation through the game.

A second factor to be taken into account when interpreting the evaluation results is the learning curve: the participants that played condition A (the video chat game) first, and condition B (the one without chat) second had the opportunity to explore the game interface together using the video chat, whereas the other participants didn't have that opportunity. In these cases, the game without video chat might have been rated higher due to the participant's acquaintance with the game: since they have already played it, it is more familiar, and can therefore be given a higher appreciation. Several participants pointed out this familiarity issue, and talked for instance about them "starting to get the procedure" the second time they played the game. Since the order in which the conditions were played were reversed for half of the test groups, it is possible to account for this learning effect.

When comparing the evaluations given by the participants that played the game in reverse order (condition A first vs. condition B first), it is clear that the learning effect has only limited consequences on game enjoyment. Only two participants explicitly stated that they liked the game better the second time they played it, solely based on the fact that the game was more clear to them the second time. All other participants explaining their preference made reference to the availability of the video chat, rather than their familiarity with the game. This shows that the (un)availability of video chat generally influenced game enjoyment stronger than familiarity with the game.

3.3.2 User interface discussion and game evaluation

The amount of time spent discussing the user interface of the game (and thus, the time older participants spent exploring the game interface while the younger participants helped them) didn't influence the evaluation of the video chat game in a negative way. The participants rating the video chat game as equally fun or less fun (participant groups 3, 4, 7, 10, 12, and 15) didn't discuss the user interface of the game more than other couples (see Fig. 4).

The other way round, couples 5 and 6, discussing the user interface of the game at great lengths, and guiding each other through the game, explicitly said they liked the video chat game more, and both gave it the highest "fun" score ("very pleasant"). Learning how to operate the game interface wasn't considered very frustrating, but instead seemed to be a natural topic for conversation. Even the younger, helping participants agreed on this, commenting about "helping each other out", and it being "better to play as a team". One older player commented on this during the game: *"You're really helping me a lot!"* This "helping" behavior was considered quite normal. On the one hand, test groups in which the elder had equal, or even superior computer skills, generally didn't discuss the game user interface very much, if at all. On the other hand, test groups in which the elder had little computer skills, this fact was naturally acknowledged by both parties, and the younger-helping-the-elder behavior emerged as a natural consequence.

There is, of course, an important prerequisite for this kind of conversation: especially the younger players needed to be patient in helping out the older players, and a lot of time was spent on guidance. This patience seemed to create no problems during the gaming sessions. The younger players in the games with a lot of discussion and guidance on the user interface were rated as "pleasant", whereas these players rated the games without video chat as "not pleasant". This suggests that the younger

participants also enjoyed explaining their (grand)parents how to play the game.

3.3.3 Younger players' game play

In the previous section, it has been pointed out that the elderly value the social aspect in playing games very much. Nevertheless, the evaluations of the game by the younger participants indicate that the same (at least partially) is true for younger users: 80% of the players liked the game with video chat more than the game without video chat.

These results indicate that also for younger players, video has added value in the shopping game. This is probably closely related to the fact that the game has a rather "slow" progress, without much exciting game play or game mechanics. Younger participants characterized the game without video from not very exciting to downright boring. Adding video to the game provided a new dimension which made the game fun again. As many popular online (multiplayer) games without video communication already illustrate [29], having direct video communication is not necessary for younger players to have a good gaming experience. The shopping game's results, however, seem to indicate that having such communication can make an otherwise "slow" game more interesting for younger players.

3.4 Limitations

The design of the test setting had some limitations related to the communication tagging used in this study. These limitations include the test setup as a usability test in a laboratory setting.

The usability test setup meant that both test participants were guided by a test facilitator, explaining the general goal of the game and observing the game progress. Participants could either communicate with the other test participant, or with the test facilitator conducting the test. This made for a limited amount of "mixed" conversation, with one test participant making a remark to the facilitator, to which the other test participant in his turn reacts, setting of an entire conversation.

Additionally, the test subjects had to come to the usability laboratory, and were asked by the test facilitators to play the game. This context is different from a home context in which there is no external motivation to play the game, and communication can be more informal and free. Possible consequences of this setting are that communication between the participants is more formal to the point and more focused on the game.

4 Conclusion and implications for intergenerational game design

4.1 Conclusion

This paper presented a study of an intergenerational multiplayer computer game, in which players are able to communicate using video chat. A brain training game was evaluated with and without video chat, by couples of two players. Conversations between these players were recorded, timed, and tagged according to the conversation contents. Afterward, these results were compared with the "game pleasure" ratings given by the participants.

The case study of the shopping game showed that extra communication functionality is often welcomed by both the older and the younger users. The reasons why the extra communication technology is appreciated, however, differ. Literature points out that for older users, social contact is an important goal for playing games in itself [22, 25]. For younger users, communication functionality can add interest to a game that in itself is appropriate for older people, but can be a bit "slow" for younger participants.

Offering this kind of communication facilities, it is important to allow players to take maximal advantage of it. For instance, direct communication can be a very useful channel to coach and guide elderly, mostly less computer-literate users in playing the computer game, both in the actual game, and in exercise modes. Our results suggest that this kind of collaboration/guidance can be very rewarding for the older as well as the younger player. Younger players can easily share their knowledge of and experience with digital media in a fun, understandable, and face-to-face way. With the necessary experience in playing games, older users that are less familiar with computer games can even take control of the game, instead of staying in a subordinate, "computer-illiterate" position. Video chat used in an intergenerational gaming context can be a fun, useful addition to the gaming experience of both older and younger players.

4.2 Implications for design

The results of the shopping game evaluations can be summarized in a number of pointers which can be useful for future intergenerational game design. These implications are outlined in this section.

> *In intergenerational multiplayer games, use video chat to add value for older as well as younger players.* Video chat functionality can add an extra social dimension to games created for the elderly. This extra dimension can make "slow" games more appealing for younger users, as well.

Moving from one game phase to the next should happen simultaneously for all players. As the communication channel can also be important for explanation and helping out the older players, moving *through* different game phases should be simultaneous. This allows younger players to give extra support at all times, without having to explain game features that are not accessible because the players are in different game stages.

Introduce an extensive exercise mode. As older players are generally somewhat insecure when playing new games, it is recommended to include an exercise mode that shows exactly the same content on both the older and the younger player's screen. In this way, all players can explore the game together, and the younger users can show how the game works in an easier, collaborative way.

Design games in which all players alternately can "take the lead". Younger players are typically more at ease using modern communication technologies. This familiarity with technology was observed in the shopping game when younger players often took the lead in the navigation through the game, leaving the older user in a somewhat subordinate position. Designing games in which players alternately can take control of game progression can allow the elderly to take the lead position, once they feel comfortable.

Allow games to be played both with and without extra communication functionality. As one of the test sessions (participant group no.7) showed, the availability of (video) chat doesn't necessarily mean that the players are keen on using that functionality. Awkward situations can arise when the video chat is always on, e.g., when players can see and hear each other without feeling the need to talk to each other. According to the gamers' subjective preferences, it is advisable to allow players to switch freely between playing with or without communication facilities. The changes in the game play and the game interface due to this switch should be kept at a minimum.

4.3 Future research

The study presented in this paper opens up a number of relevant questions for future research into intergenerational communication during gaming. In this study relating to video communication, it was found that the explicit use of the video dimension of the communication is limited mostly to waving. Therefore, a follow-up study could be conducted contrasting audio-based communication with audio–video communication. This study would provide extra information about the way communication during gaming is influenced by the presence of video.

Additionally, to overcome the drawbacks of the usability test setting and to obtain a more accurate picture of real-life communication, it would be necessary to conduct an experiment in the user's natural environment, not in a test laboratory. A more extensive field trial with unobtrusive, remote testing in which test participants can play games at home would give more information about "real-life" communication.

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