Non-player character as a companion in cognitive rehabilitation for adults - Characteristics and representation

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Abstract. A lack of social support reduces the chances of successful rehabilitation. However, the social environment changes considerably during this time. Therefore, fostering consistent social contacts is highly relevant. To address social relatedness in software-based cognitive therapy during rehabilitation we intend to use a non-player character as a companion. In this work we analyze possible forms of representation of the companion based on required characteristics, age and gender to achieve this goal. These were set in relation to age and gender of the user. Three female and three male companions in three age groups were created and subsequently tested in an explorative feasibility study with 40 participants. 50% of participants preferred a female middle-aged companion, 25% a younger male. Older companions were chosen only by women. Regarding the gender, 62.5% chose a female companion. We present an orientation for development of non-player characters as companion in software-based training for cognitive rehabilitation.

Keywords: Non-player Character, Cognitive Rehabilitation, Social Relatedness

1 Introduction

Software-based training is used in cognitive rehabilitation as a successful therapy for brain damage [1]. Depending on the damaged region of the brain, cognitive deficits such as in working memory, logical thinking, visual processing or attention may result. In addition, motoric restrictions, speech and language disorders can occur. Strokes are the main cause of acquired disability in adulthood [2]. Accidents with brain damage can also be a cause. Frequent and regular training in inpatient and subsequently in outpatient rehabilitation and / or home training is important for successful rehabilitation [3]. The success may take months to years and cannot be guaranteed. A high level of social support leads to a faster and better rehabilitation after a stroke. In contrast, social isolation is a particular risk of poor rehabilitation outcomes [4] or higher mortality rate [5]. Especially in eHealth, dropping out before completing the goal is high [6]. In home

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training, patients need a high level of motivation in order to carry out the training, as the training is no longer supervised by therapists at every session, as in the clinic.

Existing social contacts can be reduced considerably by the stay in the clinic, the temporary or complete leaving of the workplace and motor and cognitive restrictions. To overcome this problem, we want to address the human needs for consistent and motivating social support in software-based cognitive training during rehabilitation. Therefore, we propose integrating a non-player character (NPC) as a companion within the training software, who will accompany the patient during the whole time of rehabilitation (in the following text this NPC is only called companion). The companion should neither replace the therapist, nor real social interaction, but offer a stable accompaniment.

The target group are patients with acquired brain damage who are undergoing cognitive rehabilitation. There is a large number of studies that deal with the relationship between therapist and patient and deal with different effectiveness factors. This includes, among other things, the therapist's empathy and appreciation [7, 8]. Similar characteristics may be assumed for a companion. However, there are large demographic differences between patients who perform software-based therapy. Therefore, the requirements for the characteristics of a companion can vary widely. Likewise, it can vary how a companion is perceived and which characteristics are attributed to him. To analyze this, we developed a questionnaire, visualized and integrated different characters in gender and age, and evaluated them exploratively in a feasibility study. We focused on the following research questions:

Q1. Which characteristics are desired for a companion?
Q2. Which age of the companion is preferred and why?
Q3. Which gender of the companion is preferred and why?
Q4. Does the reason for the selection match the previously desired characteristics?
Q5. What are the characteristics of the choice of a companion in terms of the age and gender of the participants?

The main contribution of this paper is to analyze which characteristics are needed for a companion in cognitive rehabilitation therapy, and what type of companion these characteristics are attributed to, by which participants. In the cognitive field, analyses for the representation of companions in software-based therapy, especially with regard to social relatedness, have so far been neglected. Our results indicate an approach for the use of NPCs as a companion in software-based cognitive training in rehabilitation to create lasting social in-game relationships and create possibilities of its use. This may promote the feeling of social relatedness, motivate intrinsically and support the patient mentally during the rehabilitation process in the long-term [9].

In the following we first give an overview of social relatedness, avatars and NPCs used in games and therapy. Then we present the different NPCs we developed in different gender and age groups and the execution of a feasibility study. We sorted the results, visualized and analyzed them. Finally, we discuss the results and possible further uses of NPCs in software based training in cognitive rehabilitation.

2 Related Work

Social relatedness, along with autonomy and competence, is one of the central factors of self-determination theory, which describes the psychological needs for intrinsic motivation [10]. In games, they are able to influence the fun of the game and the future gameplay independent from each other [11]. We want to use this to support motivation of the patient in therapy by promoting social relatedness. Social relatedness describes the human need for integration into a social environment and belongingness [12]. Reinforcing this feeling encourages people to become more involved themselves [13]. Common goals and experiences, as well as highlighting cooperation can strengthen the sense of social relatedness of team members [14]. Social structures can arise on interpersonal contacts in the real or virtual world, but also on contact with non-realistic characters. The cooperation with teammates (for example NPCs) successfully affects the sense of social relatedness [15]. Elements that are assigned to the area of socialization indicate only neutral to positive influence on players [16].

Gamification elements are elements that are typically used in games, but are inserted in a different, non-game context [17]. Their effectiveness, is not only based on their general, but on their conscious, conceptually targeted use [18] and their perceived value to the user [19]. Therefore, the mechanics of the NPC shall be used as a gamification element in cognitive rehabilitation and be adapted to the needs of the patient. Serious games are games that pursue a goal outside the game [17], such as therapy [20] or education [21]. In the field of motoric rehabilitation, it has been shown that serious games increase the effectiveness of the corresponding training. However, they combine different gamification elements, but analyses are required for individual gamification elements [22].

Avatars are used in current software-based training for self-representation to reflect the patient's movements or to demonstrate desired movements [23]. This shows that digital characters in rehabilitation software have already been used with success, which shows a positive basis for our research. However, these are oriented towards the functionality of the exercise in motoric instead of cognitive rehabilitation and representation of the user. Avatars are also used in serious games as player-character for cognitive training of attention for children with attention deficit hyperactivity disorder (ADHD) [24]. As another possibility of using digital characters, we want to propose an NPC in our work that guides the patient. The visualization of NPCs is based on the influence of social norms and should correspond to the expectations of the user. This results in expectation regarding appearance, behavior and role models, which in turn influences the behavior of the player [25]. Therefore we analyze whether there is a trend for expectations. And if there is a trend, we want to use it to influence the patient's behavior positively in the use of the software-based training.

In computer games, companions are often expected to have the basic attributes skilled, helpful, nice, attractive and naive [26]. Further, the game identification of the players is related to the interaction with the companions [27]. However, the focus of such research is often on a younger healthy target group which plays for fun.

3 Explorative Feasibility Study

3.1 Development of Elements of the Study

In this study, we analyzed the characteristics required for a companion of patients in cognitive rehabilitation. In addition, we analyzed preferences for different types of companions in the representation. For this, we created visual representations of three female and three male companions (Fig. 1). For each group one companion was created in the range under 35 years (young), 35 - 49 years (middle aged) and over 50 years (older). These were developed iteratively on the basis of feedback from three experts in the field of rehabilitation (psychology, management, design). A consistent graphic style and consistent clothing is used to minimize further influences by personal preferences e.g. in the color or clothing style and a thereby possible bias. The choice of the skin color of the NPC is based on the reason that the study was carried out in Europe and that the participants are most accustomed to it in their everyday life. Primarily the face is modified by the change of the age and age-appropriate representation of the hair, secondarily the age- and gender-appropriate body form.

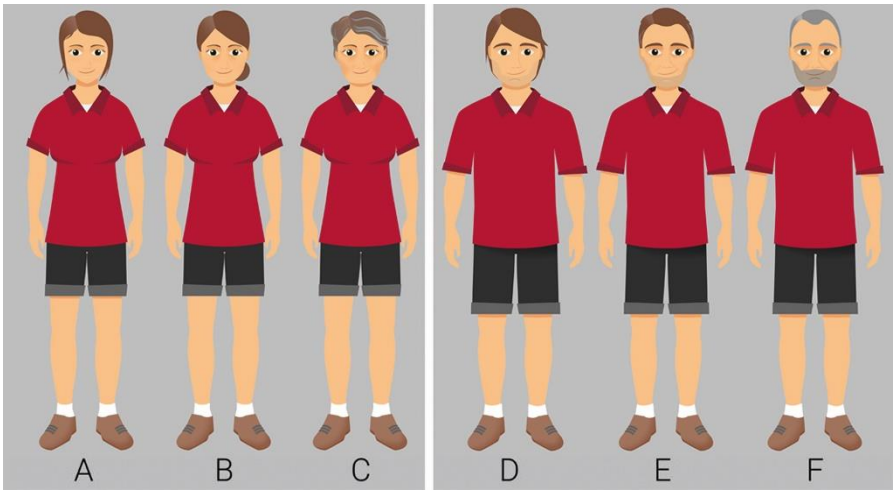

Fig. 1. Visualization of the six different companions used in the study, A-C Female (age young to old), D - F Male (age young to old).

3.2 Methods and Material

An explorative feasibility study was conducted based on a structured interview. First, the participants were informed about the voluntary participation, goals and background of the study. It was also brought to mind that personal perception and subjective opinions are at the center of attention. The time of rehabilitation was compared to a long hike. We asked closed questions with predefined answers to focus a decision between the companions. In addition, we asked open questions with free responses on characteristics and the reasons for the selection of the chosen companion. In this way, we

wanted to identify the aspects that are personally relevant to the participant without influencing him or her beforehand. With regard to our questions (Q1 - Q5) we proceeded as follows:

a) Participants were asked what characteristics a companion needs to have in order to take the companion on the long rehabilitation trail (open) (Q1)
b) Selection of one of three possible female avatars as companions (A, B, C) based on pictures (closed) and the reason for the selection (open) (Q2)
c) Selection of one of three possible male avatars as companions (D, E, F) based on pictures (closed) and the reasons for the selection (open) (Q2)
d) Selection between the two avatars previously selected in b) and c) as final selection based on pictures (closed) and the reasons for the selection (open) (Q3 and Q4)
e) Collection of demographic data: age group (<20, 20-29, 30-39, 40-49, 50-59, 60-69, 70-79, >80), gender and existence of acquired brain damage (Q5)

With regard to the open questions, we summarized the same answers, counted the frequency of naming and sorted the answers based on this. Afterwards, for question a), similar characteristics were clustered. Concerning b), c) and d), we analyzed the occurrence for conspicuities with regard to age and gender of the participants.

3.3 Participants

The study was conducted at the open day of a german University Hospital with attached outpatients clinic for cognitive neurology in September 2018. 40 participants took part in the study (female: n=24; male: n=16). They are composed of patients in cognitive rehabilitation (n=5) and persons with professional or personal knowledge and connection to the topic and / or interest in (n=35). The age groups ranged in steps of ten from under 20 to over 70. According to experts, the age distribution curve reflects the approximate distribution of patients in cognitive rehabilitation and is shown in Fig. 2.

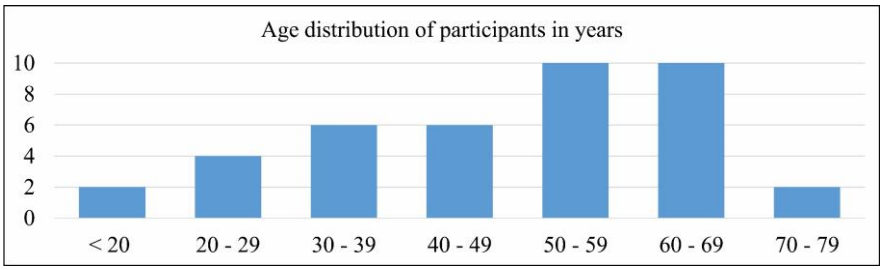

Fig. 2. Age distribution of participants in the study.

The participants were personally asked about their interest in participating in the study. They were selected by us on the basis of their age, which fits approximately to this distribution, and otherwise without further selection criteria. All participants come from

the European cultural area. All participants took part voluntarily in the study and were not rewarded. The study was conducted in Germany.

4 Results, Clustering and Analytical Procedure

In the following, the answers, frequencies and / or percentwise distribution of answers for a) - d) are presented. The results for step a) are shown in Table 1. It shows the characteristics that participants list a companion should have. After sorting and clustering the answers, a focus on character, knowledge and interpersonal behavior is apparent. The results for step b) are shown in Fig. 3.1. In this selection of female companions in different ages, the middle-aged female companion B is preferred. The results for step c) are shown in Fig. 3.2. In this selection of male companions in different ages, the younger male companion D is preferred. The results for step d) are shown in Fig. 3.3. A final selection was made between the previously selected female and male companion. 50% of the participants preferred the middle-aged female companion B. Additionally, for b), c) and d), Fig. 3 lists the reasons for the selection on the right axis, or below. The relations resulting from inclusion of e), the demographic data, between the chosen companion and the age and gender of the participant are described in Table 2 and at the end of this section. The focus here is on conspicuities that emerged in the data analysis.

Table 1. Sorted and clustered answers for a). The number in brackets shows the frequency of naming by all participants. Characteristics without brackets were mentioned once.

Character (44): friendly (4), authoritative (4), empathetic (4), relaxed (3), patient (3), clear (3), charismatic (smile / be positive) (2), open-natured (2), demanding (2), serious (2), nice, considerate, understanding, uncomplicated, not too soft, energetic, assertive, distinct, strict, resolute, not so serious but funny sometimes as well, also sometimes sarcastic / black humor, objective, helpful, honest
Type / Optical (4): beeing able to walk well, sporty, more dynamic than oneself, both feet on the ground
Behavior / Knowledge (23): competent (7), knows what the best way is especially for me (giving feedback) (5), knows the situation and knows what it is like and how to deal with the situation (2), someone who has gone through this himself, able to give expert advice, giving feedback even if it is negative, explain what makes sense / what doesn't, giving background information, open to questions, interested in the field, bringing the goals I have in line with the therapy, dealing with it individually
Interpersonal (27): motivating (6), when I don't feel like it / have a low point, motivate me to do it (3), must be able to talk to him (2), must be able and willing to listen (to one's own problems) (2), friend (2), relaxed atmosphere, person in a position of trust, right chemistry, says what to do, takes the lead, pays attention if one does the tasks, supporting, doesn't force you, calming, provide security, able to catch me, get to know each other on a neutral basis

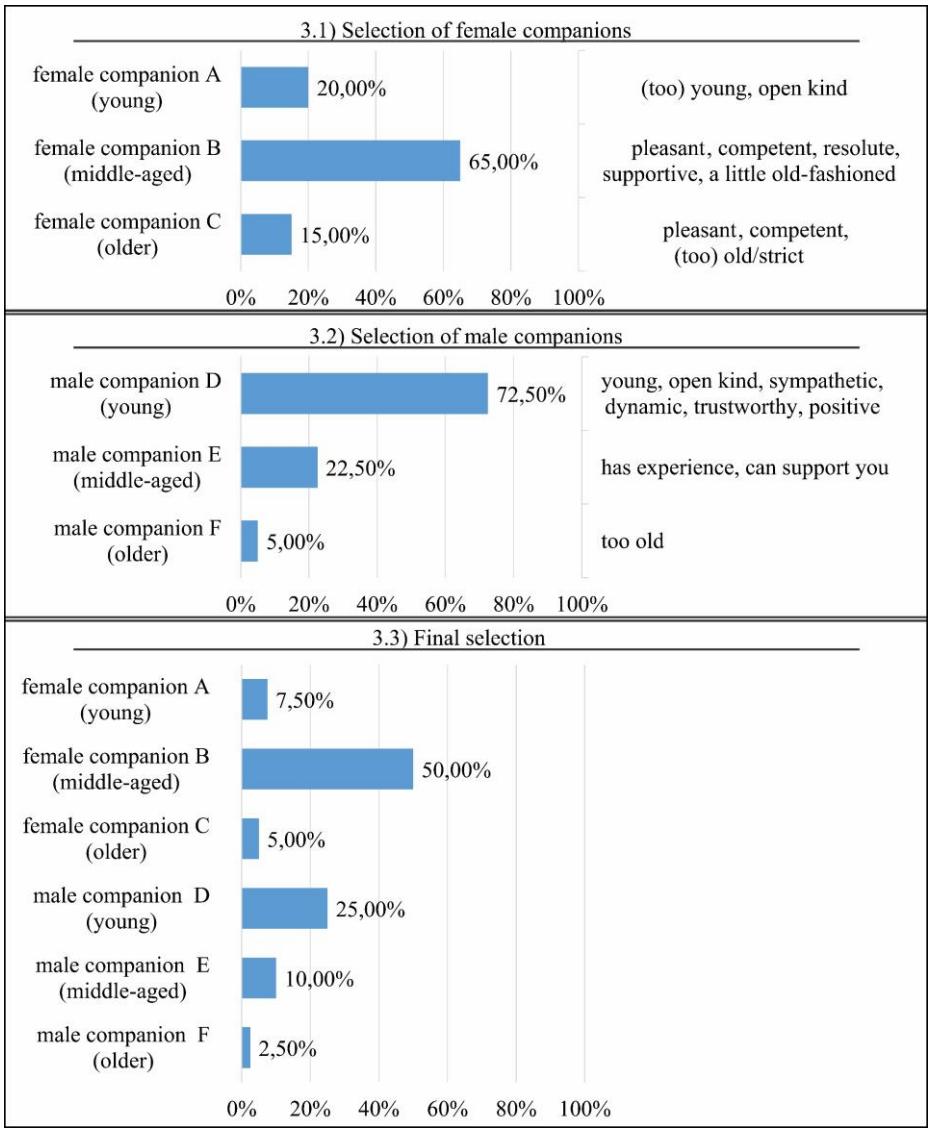

Fig. 3. 3.1) percentwise selection of female companion and reasons for selection, **3.2)** percentwise selection of male companion and reasons for selection, **3.3)** percentwise selection of the final companion.

With regard to Fig. 3.3, the reasons for selection after clustering by frequency of naming are as follows: sex (11), animating / supporting (6), competence (6), sympathy (6), empathy (5), sense of security (5), trust (4), assertiveness (4).

Table 2. 2.1) percentwise selection of companions in b) and c) based on age group of the participants**, 2.2)** percentwise selection of companions in b) and c) based on gender of participants, **2.3)** percentwise final selection of companions in d) based on age group of the participants, **2.4)** percentwise final selection of companions in d) based on gender of participants

	Chosen companion according to b) and c)							
Participants	**female A**	**female B**	**female C**		**male D**	**male E**	**male F**	
2.1) age								
Young (<30)	5%	7,5%	2,5%		12,5%	2,5%	0	
middle aged (30-59)	7,5%	42,5%	5%		32,5%	17,5%	5%	
old (>60)	7,5%	15%	7,5%		27,5%	2,5%	0	
Overall	20%	65%	15%		72,5%	22,5%	5%	
2.2) gender								
women	20,83%	54,17%	25%		83,33%	8,33%	8,33%	
men	18,75%	81,25%	0%		56,25%	43,75%	0%	
	Chosen final companion according to d)							
Participants	**female A**	**female B**	**female C**	female overall	**male D**	**male E**	**male F**	male overall
2.3) age								
Young (<30)	0	2,5%	0		0	2,5%	0	
middle aged (30-59)	5,00%	32,5%	2,5%		15%	7,5%	2,5%	
Old (>60)	2,5%	15%	2,5%		10%	0	0	
Overall	7,5%	50%	5%		25%	10%	2,5%	
2.4) gender								
women	8,33%	45,83%	8,33%	62,5%	33,33%	0	4,17%	37,5%
men	6,25%	56,25%	0	62,5%	12,5%	25%	0	37,5%

Taking account of e), the demographic data, only 7.5% prefer the oldest companion (female C and male F) in the final selection (Table 2.3). Of these, all were female in the age range between 40 and 69. The young female companion (A) was chosen by 7.5%, of whom 5% were female in the age range between 50 and 69 and 2.5% male in the age range between 20 and 29. The middle-aged male companion (E) was chosen in the final selection exclusively by men (Table 2.4) who were equally distributed between the age ranges from under 20 to the ages of 50 - 59. The older man (F) was chosen exclusively by women between the ages of 50 and 59.

Regarding only the participants with brain damage and cognitive rehabilitation, 60% chose the middle-aged female companion (B), 20% the younger female companion (A) and 20% the younger male companion (D). This results in 80% of the participants with brain damage who chose a female companion.

5 Discussion

In this work, requirements for the characteristics of a virtual companion in software-based cognitive therapy in rehabilitation and selection criteria were analyzed. These were based on age and gender of companions and participants.

To support the patient's motivation, the companion can guide him starting from the initial training. He can show the patient on a map his progress in rehabilitation, remind him of good experiences, note frequent mistakes made during training and can remind for the next training. Comparable use cases, such as informing about a task or helping the player, were included in classifications within research in games [25]. The companion's skills and clothing improve through regular training or can be selected. This enables companion to develop further together with the patient. The aim is to support the regular performance of the training required for rehabilitation.

Software-based training in cognitive therapy often involves several individual trainings (e.g. for deficits in attention, memory or executive functions). These differ in rules and tasks. In the therapy for adults the trainings are carried out one after the other. There are rarely integrated characters or social relatedness. Through our suggested use of NPCs these can be modified. They can be used in individual trainings as well as in an overarching role to connect the trainings. Previous research has shown that due to social norms there are expectations of the user to the NPC [25]. Based on this, the patient's behavior could be positively influenced by a companion considered as positive as possible, which may support regular training. This will be considered in further studies.

In the presented study the desired companion is predominantly described as an empathetic friend and competent at the same time (Q1). The companion has to take the leading role and be motivating, but also strict if necessary. This shows the desire for trust and guidance in a situation that cannot be assessed by the individual because the necessary skills are lacking. The focus is therefore not on appearance. That is highly relevant for the development of a companion for use in software-based therapy for which the characteristics analyzed in a) should be in the focus. Developed NPCs should also be evaluated on this.

The stated needs with regard to characteristics and that being naive is no requirement, differs from the expectations of a classic companion in computer games. Rather, a combination of companion and mentor is the result. The mentor is additionally described by Rogers et al. [26] as wise and intelligent, but also old, which does not correspond to the expectations regarding a companion in rehabilitation. This implies that the requirements for the use of a companion in rehabilitation differ from those of normal players. Existing classifications [25, 26] are an important basis for comparing these systems with the needs of patients and possibly extending them.

The selection of the younger to middle-aged companion (Q2) could be based on the fact that in long-term strength may be needed for support. If older avatars are chosen, patients frequently stated that the reason is due to the closeness to one's own age. This may indicate the need to bring up empathy for one's own situation. On the basis of age (Q3), the middle-aged (female companion B) is preferred for the female companions and among others described as pleasant and competent. Among male companions, the

younger one (male companion D) is preferred and described as sympathetic and dynamic. The desired characteristics, which were stated previously by each participant, were later often linked to the choice of gender when the reasons for the final selection were stated. The overall desired qualities for the companion are predominantly attributed to women in everyday life, which could explain the final tendency towards the female companion. Compared to the previous assessment (Q4), however, none of the participants had expressed gender-specific wishes. The companions selected in the final selection were otherwise attributed congruent characteristics as desired before. These were thus confirmed based on the representation of the companions. This may show on the one hand that in Q1 the gender classification did not seem relevant for the participants. On the other hand, it may also show that previous characteristics were assigned to the characters shown. Regarding the choice of age and gender of respondents (Q5), it was found that women also chose the older characters, while men did not. Women were more likely to choose the younger male companion, men also the middle-aged. The younger female companion is preferred by older women and younger men. Here various aspects, such as the protective instinct of the older participants or the sexuality of the younger participants may be involved. Due to the low final selection of some of the companions, this can only be seen as an indication.

The comparison of data between participants with and without brain damage shows that the distribution of the selection is very similar. That is apparent from the fact that the trends in the selection of companions, both female and male, and the final selection correspond. It can be assumed that the presence of brain damage does not change the needs in the presented situation, because all participants were asked about their personal preferences. However, the observed trend cannot be generalized due to the small sample of patients. Persons without acquired brain damage know the situation of patients, but are in a different emotional situation. The acquired brain damage and the resulting experience may lead to further effects in the use of NPCs. Further studies should be carried out with patients and the effect on patients during use of NPCs should be examined more closely. A further influence on the data can be assumed by the unequal distribution of the participants between men and women. However, if the percentual distribution of the final selection is compared between female and male participants, it is exactly the same. 62.5% of both men and women chose a female companion and 37.5% a male companion in the final selection (Table 2.4). From this, it can be assumed that the gender of the participants does not influence the distribution of the selection of the gender according to the companion. In this study, one visualization was used per age and gender. There may be an influence from preferring a particular graphical representation. This can be further investigated by using different visualizations per category.

Due to the exploratory approach to the feasibility study, the results of the individual categories should be considered as trends. Slight to strong deviations from the trend can arise individually due to the unique personalities and resulting needs of patients. The results generally represent the field of cognitive rehabilitation. Whether there are differences between various neurological diseases needs further analysis. The participants come exclusively from the European cultural area, so the results can only be related to this particular demographic. Therefore, the results provide a basis for further studies to consider the conspicuous results found here separately.

6 Conclusion

This work shows an analysis of possible representations of NPCs as a companion in cognitive therapy during rehabilitation based on characteristics, age and gender of companion and participants. This was done using three visualized female and male characters in each case as selections in combination with a questionnaire on preferred characteristics and reasons for selection. Results show a trend to use a middle-aged female or a younger male companion for software-based cognitive training in rehabilitation. The relevant characteristics are to be competent and give feedback, motivating but at the same time determinant, friendly and empathetic. It worth further investigation because a trend has been shown, which should be considered further if companions are integrated in cognitive training software. Furthermore, various possible uses for the companion should be evaluated. In the future, it could be possible to present the progress of the patient, to remember training times or to give hints for improvements in training and everyday life using the optimized companion as an application purpose.

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