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Computerized Cognitive Training for the Elderly

A study evaluating use of the Brain Trainer Plus™ in care homes for elderly people

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Brain Trainer Plus™

Abstract

Background: Old age is often associated with age-related cognitive decline. Computerized cognitive training programs can improve cognitive functioning of the elderly people. However, such programs typically suffer from low uptake and usage in practice. This explorative cross-sectional study examined the use of the Brain Trainer Plus (BTP), a computerized cognitive training device developed for use in care homes for the elderly in the Netherlands, and investigated which environmental factors and user characteristics were associated with (non-)usage of the BTP. The attitudes and beliefs of the staff members were also taken into account.

Method: In total 94 residents and 35 staff members of Topaz care homes participated in the study. Users and discontinued users of the BTP were compared in order to make meaningful comparisons. The questionnaires for residents and staff members were based on the Technology Acceptance Model.

Results: Similar to research on general computer use of the elderly, the BTP suffered from low uptake and usage. Facilitating conditions were mostly mentioned as barriers to uptake. Gender, perceived enjoyment and social influence were found to be related to usage. There were no significant findings regarding the attitudes and beliefs of the staff members.

Conclusion: In this explorative endeavour some factors have been found associated with uptake and usage of CCT programs for the elderly people. Recommendations for future research were made in order to improve adherence to and optimize usage of future computerized training interventions for the elderly and e-health programs in general.

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Computerized Cognitive Training for the Elderly: a study evaluating use of the Brain Trainer Plus™ in care homes for elderly people

The number of elderly people has been growing as has their life expectation, this will continue in the years to come. In health perspective this can be a problem, since old age is often associated with cognitive decline (Kueider, Parisi, Gross, & Rebok, 2012). Cognitive decline involves complaints in memory, focus maintenance and problem solving capability, which impact the activities of daily living and social interaction. Therefore, the decline negatively impacts the quality of life of the elderly people (Maki et al. 2014). Not only the individual, but also the society experiences the substantial impact of cognitive decline in elderly people, in terms of healthcare costs. The medical costs for elderly people suffering from mild cognitive impairment (MCI) are 44% more than the costs for cognitively healthy elderly (Zhu et al., 2013). People with MCI have a 43% higher risk of developing Alzheimer's disease, this is the most common form of dementia (Trimbos, 2010). With healthcare costs of 4.8 billion euros in 2011, dementia is among the three most expensive diseases in the Netherlands (Ministerie van Volksgezondheid, Welzijn en Sport, 2011). Interventions aimed at decreasing these social and financial costs regarding cognitive decline in elderly people are needed.

1.1 Cognitive Training

Research shows that cognitive training can be effective in preventing cognitive decline in elderly people by improving cognitive functioning and quality of life (Fernández-Prado, Conlon, Mayán-Santos & Gandoy-Crego, 2012; Kueider et al., 2012). In their review Mowszowski, Batchelor and Naismith (2010) studied whether cognitive training can be used as a tool to prevent cognitive decline in the elderly people, they looked at the different stages of decline. Their research shows that cognitive training has shown to be effective especially with healthy elderly people and with elderly people who are a 'risk' group, like people suffering from MCI. Findings for elderly people with Alzheimer's disease were mixed Nonetheless, their review suggests that cognitive training can be used as a primary and secondary prevention tool to prevent and treat cognitive decline in the elderly. Especially the computerized versions of cognitive training were shown to be effective, according to the researchers.

1.2 Computerized Cognitive Training (CCT)

In the recent years computer-based cognitive training is proliferating, since it has proved to be cost-effective compared to the traditional face-to-face training methods (Kueider et al., 2012). Several studies have shown computerized cognitive training (CCT) to be effective in improving cognitive functions (Bozoki, Radovanovich, Winn, Heeter & Anthony, 2013; Cipriani, Bianchetti & Trabucci, 2006; Günther, Schäfer, Holzner & Kemmler, 2003; Kueider et al., 2012; Peretz et al., 2011). For example, in the study of Günther et al. (2003), nineteen residents of a home for the elderly with age-associated cognitive impairment participated in a 14-week CCT program, which included computer-based exercises to train the most important cognitive functions. Such as the game 'point by point' where participants have to connect numbers line by line in order to stimulate attention and visio-motoric coordination or the game 'division' where lines should be divided in equal parts in order to train spatial perception. After the intervention participants showed significant improvements in cognition, for example it was easier for the elderly participants to remember lists of words, and information was grasped and processed faster. Most of these improvements were maintained after five months. Cipriani et al. (2006) demonstrated that CCT was also beneficial for elderly people with MCI and Alzheimer's disease. The participants attended a 4-week training period with games to stimulate attention, memory, perception, language and non-verbal intelligence. After a break of 6 weeks, the same participants underwent another 4-week training period. At baseline, after three months and after the second training period, cognitive functions were measured. The elderly people suffering from MCI, as well as the participants suffering from Alzheimer's disease showed significant improvements in global cognitive status and/or in specific cognitive areas.

1.3 Low usage computerized interventions

Although several studies report the effectiveness of CCT with elderly people, research on usage of such programs is scarce. Czaja et al. (2006) showed that elderly are less likely to use technology in general, compared to younger adults. They are typically less familiar with computers and tend to feel more anxious towards and less confident using computers (Saunders, 2004). High non-usage and drop-out rates are found when looking at studies promoting computer use in general among elderly (so not specifically focused on training cognitive function) (Adams, Stubbs & Woods, 2005; Cody, Dunn, Hoppin & Wendt, 1999;

Namazi & McClintic, 2003; Tse, Choi & Leung, 2008). In the study of Cody et al. (1999) elderly people were trained to use a computer, but within the four month intervention period 48% of the participants withdrew from the study. Low self-efficacy, high computer anxiety, less positive personal attitudes and low levels of social support were among the reasons for withdrawal. Similarly, Namazi and McClintic (2003) studied 24 elderly people in a long-term care setting, who participated in a computer class intervention in order to become independent computer users. At first the residents were very enthusiastic in learning how to use the computer. However after 15 months only 5 residents remained in the class and frequently used the computer. Physical, cognitive and personal factors of the participants, technological factors of the device and environmental factors were mentioned as reasons causing the high drop-out. The researchers mentioned that the residents with dementia functioned extremely well, but only for a short period of time. They could not memorize what they had learned in a previous session, therefore they stopped coming after three sessions.

Not only computerized interventions for the elderly suffer from low usage, but e-health interventions in general suffer from high attrition and low usage (Christensen & Mackinnon, 2006; Eysenbach, 2005). Wangberg, Bergmo and Johnsen (2008) reported adherence rates of 0.8 to 34% for three online intervention programs, concerning diabetes-self management, smoking cessation and the use of an online personal health record. In all three trials participants dropped out at a high rate early in the trial. The researchers found that self-efficacy of the participant in wanting to improve their own health impacted usage of the intervention. Also tailoring the content of the e-health intervention to the individual, like using the name of the participant in the program or providing feedback about the situation of the individual compared to a norm group, was found to positively affect usage. Furthermore it is important to use follow-up, like sending an email as a reminder to use the program, in order to increase usage.

1.4 Usage of CCT programs in a trial compared to usage in practice

The studies regarding CCT interventions for elderly focus on effectiveness of the intervention, but information regarding usage is often not mentioned. However, in contrast to our expectations drop-out rates in these studies are rather low. For example in the study of Nouchi et al. (2012) to investigate the impact of the brain training game Brain Age on cognitive functions of the elderly, the drop-out rate was only 12,5%. Peretz et al. (2011) mentioned a drop-out rate of 22% in their study to investigate whether a personalized CCT

game was better in improving cognitive functions of the elderly compared to a standard computer game.

There is however a difference between usage and drop-out of CCT programs in a trial connected to a study and actual uptake and usage of CCT programs in practice. In a trial participants are encouraged by the researchers, they are monitored during the trial period and asked to complete questionnaires. This personal attention and support may be the reason of low drop-out from the intervention trials. In every day practice however these aspects are lacking and the use of a CCT program is less structured, therefore there is a reduced uptake and usage. To our knowledge there are no studies on actual uptake and usage of CCT programs in practice, but some information about this topic can be found in studies regarding other e-health interventions. For example Christensen, Griffiths, Kortens and Brittliffe (2004) compared spontaneous public visitors of a cognitive behavior therapy website with participants of a randomized controlled trial of the same site, on usage and effectiveness on anxiety and depression outcomes. They found that the public users were less likely to adhere to the full program compared to the trial participants. Only 15.6% of the public users completed more than 2 modules of the program, as for the trial participants this was over 66%. These findings support our notion of the difference in actual uptake and usage of computerized programs in practice compared to usage of these programs in a trial.

The personal support and structured process of the CCT trials are not the only reasons of low drop-out in these programs. Günther et al. (2003) were positively surprised about the positive attitudes of the elderly residents of the care home, they were very open and accepting of the CCT program. After the intervention the residents wanted to continue with the program. Unfortunately, the researchers did not investigate whether or not the residents actually continued using the CCT program in practice. Furthermore, in an attempt to improve usage-rates, Bozoki et al. (2013) developed an online cognitive training game with a 'senior-friendly' interface. Based on experiences from previous studies and several focus groups with elderly people, the interface incorporated the wishes and needs of the elderly, and the game itself contained stimulating and reinforcing characteristics. Sixty community- dwelling elderly people were assigned to the intervention group, which participated in the 'senior-friendly' computer game or to the control group, which participated in a game similar in look and feel but without the senior-friendly interface, i.e., with low level interactivity and no possibility to adapt difficulty levels. The drop-out rate for the intervention group was 10%, for the control group it was 25%. According to the researchers, the critical factor in drop-out and

the willingness of the elderly people to adhere to the program had to do with the reinforcing program characteristics and the senior-friendly interface of the computer game. In conclusion, these studies show that program characteristics like lay-out of the game, the attitude of users and social support influence CCT usage in trials, this may also be the case in practice.

1.5 Causes low usage computerized interventions

Ritterband, Thorndike, Cox, Kovatchev and Gonder-Frederick (2009) pinpoint several causes for the low usage of e-health interventions in general, which can be divided in three broad categories: (a) environmental factors, (b) characteristics of the website or program characteristics, and (c) user characteristics.

Environmental factors include the setting and context in which the e-intervention is used. Lacking facilitating conditions, like ease of access or low visibility of the computerized device, or an unsupportive social environment (e.g. family, caregivers) can negatively influence usage of the e-health intervention. Several studies have emphasized the importance of a supportive environment and accommodating facilitating conditions to enhance computer use (Czaja et al., 2006; Elliot, Mooney, Douthit & Lynch, 2013; Nägle & Schmidt, 2012; Saunders, 2004). According to Carpenter and Buday (2007) the computer use of elderly people with greater social resources is enhanced, because they are more often stimulated to use the devices. Mohr, Cuijpers and Lehman (2011) argued that human social support increases adherence.

Website or program characteristics include appearance, mode of delivery and message. Regarding program characteristics low usage is related to the complexity of computer programs (Carpenter & Buday, 2007). Especially older people have difficulty with seeing the screen, handling the mouse and processing too much information. To compensate for these difficulties, the content has to be very stimulating in order to convince the elderly to adhere to the program, this however is often not the case. Overall the content is not designed taking into account the cognitive and physical limitations of the elderly persons. According to Saunders (2004) the elderly would like simpler instructions on devices that are easy to use and easily adaptable to suit sensory limitations. From their focus groups with elderly Bozoki et al. (2013) learned that elderly people want short games and repetitive play rather than extensive stories and difficult interfaces. They want to get simple feedback about their scores. It is important to have adjustable difficulty levels so the games stay exciting and there has to be a sense of reward, like being able to break one's own record. Taking these suggestions into

consideration Bozoki et al. (2013) designed a successful CCT program, since the elderly participants were eager to continue playing even after the trial period.

User characteristics related to low usage include demographic variables (old age, female gender, low education, low SES), cognitive factors (cognitive limitations, anxiety/depression, poor self-rated health), physiological functioning (including poor motor functioning and mobility, sensory limitations, and pain/discomfort), skills (less computer experience, low computer skills), and beliefs and attitudes (less treatment expectations, low interest, less motivation, low self-efficacy, computer anxiety) (Carpenter & Buday, 2007; Czaja et al., 2006; Elliot et al., 2013; Namazi & McClintic, 2003; Saunders, 2004, Venkatesh, 2015). The beliefs and attitudes a person holds towards a technological application have been shown to be very influential in predicting usage behaviour. The Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh, Morris, Davis & Davis, 2003) and its predecessor the Technology Acceptance Model (TAM) (Davis, 1989) postulated that the degree to which an individual intends to use and accept a new technology is determined by *behavioural intention* ("the degree to which an individual intends to perform a specific behaviour"), which in turn is influenced by: *perceived usefulness/performance expectancy* ("the degree to which a person believes that using a particular system would enhance his or her performance") and *perceived ease of use/effort expectancy* ("the degree to which a person believes that using a particular system would be free from effort") (Davis 1989). *Social influence* ("the degree to which an individual perceives that important others believe he or she should use the new system") and *facilitating conditions* ("the degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system") are added in the UTAUT model as determinants of behavioural intention. Perceived usefulness is the strongest predictor in utilitarian systems, where the main objective of the technology is productive use, like in a work setting. On the other hand, perceived ease of use and perceived enjoyment are the strongest predictors in hedonic systems, where the main objective is pleasure and the content is designed to encourage prolonged use, like with computer games (Van der Heijden, 2004). Additional factors in the model include perceived enjoyment, computer self-efficacy, computer anxiety, computer skills, gender and age (Venkatesh, 2015). Czaja et al. (2006) showed that in general low computer self-efficacy led to higher computer anxiety, which in turn lowered the behavioural intention to use a computer. Similar results were found regarding the elderly (Cody et al. 1999).

In summary, CCT programs have proven to be effective in improving cognitive functions of the elderly people. Although there is ample research on effectiveness of such interventions, information regarding usage is scarce. Research shows that elderly are less familiar with computers and that computerized interventions are plagued by low uptake and usage. Not only computerized interventions for the elderly, but e-health interventions in general suffer from high attrition and low usage. User characteristics, program characteristics and environmental factors are mentioned in research to cause this low usage. To our knowledge there is no CCT study investigating the influence of all of these three characteristics on usage in real life. Most of the studies are trials looking at effectiveness of the CCT program, whenever usage is mentioned, only one of these characteristics is discussed. Shedding light on these characteristics is of importance in order to improve adherence to and optimize usage of future computerized training interventions for the elderly. Therefore in the present study we will investigate actual uptake and (non)usage of a CCT program in real life. Most of the participants in the CCT studies include community-dwelling healthy elderly people (Lampit, Hallock & Valanzuela, 2014), fewer studies are done among elderly people in care homes. Therefore the present study will be carried out in care homes for the elderly. Furthermore we will not only include the residents, but the staff members will also be included in the study, since it is clear from earlier mentioned studies that the social environment is an important contributor to computer adherence of elderly people. To our knowledge no prior research exists incorporating the opinion of staff members in evaluating use of a CCT program for elderly residents in a care home.

In this study we will evaluate use of the Brain Trainer Plus™ (BTP). The BTP is a computerized cognitive training device developed for use in nursing homes for the elderly in the Netherlands. The BTP offers a variety of cognitive training games like memory, math/photo/history/music quizzes, Sudoku, and many other games that all serve to stimulate cognitive functioning, improve performance and stimulate social interaction. The BTP has tailored its program characteristics specifically to suit the needs of the elderly in order to improve usage: firstly, the BTP is a user-friendly computer with a touchscreen desktop, and easy to follow, step-by-step instructions. Secondly, its games are accompanied by exciting sound effects, and it offers the possibility to personalize the games with one's own pictures or personal questions provided by the family members in order to make it more fun to use. And finally, the content of the games answers to the recommendations of Bozoki et al. (2013) regarding self-challenge and stimulation. Elderly tend to choose games that are none too

challenging, however when the games were too easy, the users lost interest after a while. In the BTP the user has individual access, so one can immediately start to play at one's own level and if the user chooses a level that is too easy - or too difficult - the program automatically adjusts to the level of the user in order to keep one challenged.

1.6 Research questions and hypotheses

The BTP has been specifically developed to suit the needs of the elderly in terms of its program characteristics (i.e., content and appearance). It is unclear, however, whether or not the BTP is actually used in practice by the elderly. Secondly, it is unclear which environmental factors and user characteristics are associated with (non-)usage of the BTP. The research questions and hypotheses in this study, based on aforementioned research, are as follows;

Research question 1. *How frequently is the BTP used by the residents of Topaz care homes?*

Research question 2. *How is the BTP evaluated by both residents and staff of Topaz?* We hypothesized that frequent users of the device will evaluate the BTP more positively than users who used the device in the past, but stopped doing so. With respect to the staff members, it is hypothesized that staff members working on a location where the BTP is used more frequently by the residents, will evaluate the BTP more positively than staff members working on a location where the BTP is used less frequently by the residents.

Research question 3a. *Is there a difference between residents who use the BTP frequently and residents who stopped using the BTP in terms of user characteristics and environmental factors?* Analogous to earlier mentioned research we expect that the two user groups will differ from each other regarding user characteristics and environmental factors. With regard to user characteristics we expect the users to enjoy being active on the BTP more, find the BTP easier to use, and not only have a higher BTP self-efficacy but also have better general computer skills, and finally have less computer anxiety, than the discontinued users. Regarding environmental factors, we hypothesize that users will experience a more supporting and facilitative environment than discontinued users.

Research question 3b. *Is there a difference between staff members working on a location with higher frequency of BTP use by residents and staff members working on a location with lower frequency of BTP use by residents in terms of user characteristics and environmental factors?* In this explorative endeavour we hypothesize that staff members working on a location where

the BTP is used frequently, will have a higher BTP self-efficacy, will stimulate the residents more often in using the BTP and will experience the BTP to have a more positive effect on social interaction than staff members working on a location where the BTP is used less frequently.

Research question 4. *Which user characteristics, program characteristics and environmental factors are the strongest related to BTP usage among elderly residents?* The UTAUT model (Venkatesh, 2003) and its predecessor the TAM model (Davis, 1989) have shown perceived ease of use, social influence, facilitating conditions, perceived enjoyment, computer self-efficacy, computer anxiety, computer skills, gender and age to be influential in the degree to which an individual intends to use and accept a new technology. Consequently we hypothesize these factors to be related to BTP usage.

2 Method

2.1 Participants

In total 94 residents and 35 staff members of Topaz care homes participated in the study. Topaz is a large care provider in the Netherlands, with 8 nursing homes in the Leiden area. It offers 12 BTP devices to its residents. The 12 units owning a BTP device were visited during this study. Depending on their care needs, residents are offered care on the somatic or the psychogeriatric (PG) units. On the somatic units mainly physical care and rehabilitation is offered, since its residents struggle with physical limitations, for example after a surgery. The PG units provide prolonged care for elderly with advanced to severe memory and behavioural problems. The PG units are closed sections in order to provide a protected living environment for the residents. In this study 6 somatic and 6 psychogeriatric units were visited. The inclusion criteria for the participants were threefold: having access to the BTP, knowledge of the Dutch language and being able to express oneself in words or in gestures. Regarding the staff members, inclusion criteria were as follows: knowledge of the Dutch language, one has to work on a location where the BTP is used and one has to know (but not necessarily work with) the BTP.

The first part of Table 1 displays the demographics of all residents and all staff members included in the study. The data concerning users, discontinued users and non-users of the BTP will be discussed in the results section. There were more participants in this study

from the somatic care units (somatic n=59 versus psychogeriatric n=35). Most of the participants were females (63.8%). This corresponds to the higher number of females in nursing homes, since they have a higher life expectancy and are overrepresented in the higher age cohorts (CBS, 2014). The mean age in our study is 76.6 (*SD*=13.5), with a minimum of 30 and a maximum of 96 years. The minimum age of 30 in our sample can be explained by the following: nursing homes of Topaz mainly care for the elderly, however one nursing home also provides care for younger people suffering from Huntington disease, this is a neurodegenerative genetic disease. In our study population 5 participants belong to this group, therefore the minimum age in our sample is 30 years.

Staff members Topaz

The staff members of the somatic (n=18) and psychogeriatric (n=17) units of Topaz were also asked to fill out a short questionnaire to evaluate the BTP. Thirty-five staff members participated in the study, of which 34 females and 1 male. Since the main study population for this study are the residents, it was sufficient to note only gender and work unit as demographics for the staff members. These results are displayed in Table 1.

TABLE 1

Demographic Characteristics of Residents and Staff members of Topaz

	All residents		**Staff members**		**Residents: Users BTP**		**Residents: Discontinued users BTP**		**Residents: Non-users BTP**	
	N = 94	**100%**	**N = 35**	**100%**	**N=27**	**28.7%**	**N=21**	**22.3%**	**N=46**	**48.9%**
Demographics	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Gender										
Male	34	36.2	1	2.9	14	51.9	4	19	16	34.8
Female	60	63.8	34	97.1	13	48.1	17	81	30	65.2
Age in years (mean±SD)	76.6 ± 13.5		N/A		75.2 ± 12.7		74.0 ± 15.7		78.7 ± 12.9	
Unit										
Somatic	59	62.8	18	51.4	20	74.1	13	61.9	26	56.5
Psychogeriatric	35	37.2	17	48.6	7	25.9	8	38.1	20	43.5

2.2 Design and procedure

This explorative study is a cross-sectional study. Approval for the study was obtained from the board of directors of Topaz. The 12 unit managers of Topaz nursing homes were informed about the study by the board of directors. Thereafter the researcher approached them by telephone, to explain the aim of the study and what was expected from them. They were asked to distribute a short leaflet describing aim and content of the study among the residents and staff. Furthermore they were asked to hang posters about the study on the noticeboard, in order to inform the family members and/or caregivers of the residents. Approval from the ethics committee was obtained for the study.

All residents and staff members present were approached to participate in the study. The response rate for the residents was 100%. Even when residents reported not to use the BTP and therefore did not need to fill out a questionnaire, they gave a reason for non-usage of the device, which contributed to the results of the study. The response rate for the staff members was also 100%. Quantitative data was collected by means of questionnaires from the residents and staff. However, as a large number of residents in the care homes suffered from mild to severe cognitive impairment, all questionnaires were administered face-to-face by one of the researchers (JM) in a structured interview.

All *staff members* present were informed about the study and assured that participation was voluntary and that data would be processed anonymously. Subsequently, they were asked to participate in the study and asked to sign informed consent. They filled out a brief questionnaire about the BTP.

On the *somatic units* residents were informed about the aim and content of the study by the researcher. It was stated that participation in the study was voluntarily and that the data would be processed anonymously. All the residents present were asked individually if they used the BTP, data were collected according to their responses: Figure 1 shows this process. If residents answered ‘no’, they were then shown the BTP device and asked if they had ever used this device. If residents answered ‘no’ again, only gender and age of the respondent were noted and respondents were asked for their main reason for non-usage. Residents who responded that they (had) used the device now or in the past, were asked to participate in the study and signed informed consent. Where-after short, face-to-face, structured interviews were conducted to fill out the questionnaire on the basis of participants’ answers.

On the *PG units*, the same procedure was followed, the difference being that overall more time was spent, because people on these units suffer from different stages of cognitive impairment. Following the guidelines of van Baalen (2011) the researcher and one of the staff members explained the content of the study in a simple manner, using short sentences. Subsequently, the BTP was shown as a visual stimulus in order to trigger the memory of the users regarding the device. More time is given to the participants to process the information and respond. According to van Baalen (2011) 'a minimum level of orientation to place, language skills and attention to place are essential for interviewability'. Therefore, the researcher spent some time making small talk in order to gain trust and the attention of the participant, and to establish if the resident was cognitively capable to understand the questions and give informed consent on the basis of these criteria. The majority of the participants on the PG units were cognitively capable to answer the questions regarding use of the BTP. Analogous to the procedure on the somatic unit, PG residents who had never used the device were asked for the main reason of non-usage. Residents who responded that they (had) used the device now or in the past, were asked to participate in the study and signed informed consent. Where-after short, face-to-face, structured interviews were conducted to fill out the questionnaire on the basis of participants' answers. After the data collection residents and staff were thanked for their participation in the study.

2.3 Measures

The questionnaires for residents and staff members were based on the TAM questionnaire. This measure is widely used as a model for explaining user acceptance of new technology and has demonstrated reliability and validity (Davis, 1989; McCord, 2007; Venkatesh, 2003). The original TAM questionnaire was considered too long for this study, considering the cognitive limitations of the residents of Topaz care homes. Therefore perceived usefulness was not included in the study, because it is considered a more important determinant in usage of systems related to productive use, like in a work setting (Van der Heijden, 2004). In consultation with the management of Topaz, regarding length and difficulty level, a shorter questionnaire was constructed (Appendix A), with single item questions. In the first part of the questionnaire demographics were collected, including age, gender and unit (somatic or psychogeriatric). The second part of the questionnaire consisted of 12 questions, mostly using a 5-point Likert scale, where 1= 'Totally agree' and 5= 'Completely disagree' and two questions using a 10-point scale. Table 2 shows used constructs, construct definitions and questions/statements in the questionnaire. The staff

questionnaire consisted of four questions, of which three used a 5-point Likert scale where 1= Totally agree and 5= Completely disagree. One question used a 10-point scale (Appendix B). The constructs and questions can be found in Table 2.

TABLE 2

Content Questionnaires

Construct	**Construct definitions**	**Questions/Statements**
Questionnaire residents		
Frequency of use	The number of times the device is used	How often do you use the BTP?
Evaluation	Evaluation of BTP	How do you rate the BTP on a scale of 1 to 10, where 10 is excellent?
Perceived Enjoyment	The extent to which the activity of using a specific system is perceived to be enjoyable in its own right, aside from any performance consequences resulting from system use.	I like being active on the BTP.
BTP Self-efficacy	The degree to which an individual beliefs that he or she has the ability to perform a specific task on the BTP.	I can manage using BTP.
Perceived ease of use	The degree of ease associated with the use of the system.	I find the BTP easy to use.
Facilitating Conditions 1	The degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system.	I can use the BTP whenever I feel like it.
Facilitating Conditions 2	The degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system.	When I encounter problems using the BTP, I can ask the staff for help.
Social Influence	The degree to which an individual perceives that important others believe he or she should use the new system.	Others, like the staff or family members, find it important for me to use the BTP.
Computer skills	The ability (and experience) to manage a computer.	How do you rate your computer skills on a scale of 1 to 10, where 10 is excellent?
Computer anxiety	The degree of an individual's apprehension, or even fear, when she/he is faced with the possibility of using computers.	I feel apprehensive about using a computer.
Questionnaire staff		
Evaluation	Evaluation of BTP	How do you rate the BTP on a scale of 1 to 10, where 10 is excellent?
BTP Self-efficacy	The degree to which the staff member beliefs that he or she has the ability to perform a specific task on the BTP.	I can manage using BTP.
Social influence	The degree to which the staff member	I stimulate residents in using the

	stimulates residents to use the device.	BTP.
Impact social interaction	The degree to which the staff member beliefs the BTP to promote social interaction.	In my experience the BTP promotes social interaction on the unit.

2.4 Statistical analyses

Data were analysed using SPSS for Windows version 22. Independent samples t-tests and Pearson's Chi squared tests were used to assess the difference between the users and the discontinued users of the BTP. A logistic regression analysis was conducted to predict group membership to users group or discontinued users group. The assumptions for a linear regression analysis were met, except for the magnitude of the sample size considering the number of predictor variables. Therefore prior to analysis a Spearman's Rho correlation analysis was conducted to explore which predictors correlate significantly with use. With the 5 significant predictor variables the logistic regression analyses was conducted.

With regard to the data obtained from the staff questionnaires, independent samples t-tests were used to assess the difference between staff members working on a location where the BTP is used less frequently by the residents and staff members working on a location where the BTP is used more frequently by the residents.

3 Results

A total of 94 people were enrolled in the study. In order to make meaningful comparisons we divided the study population in users, discontinued users (DUs) and non-users of the BTP (Figure 1). Participants who indicated that they had never used the BTP were defined as 'non-users' (n=46). Participants who indicated they (had) used the BTP now or in the past were asked to fill out the questionnaire (n=48). On the basis of their answers to the question 'How often do you use the BTP?', participants were categorized into different user groups. People who indicated that they used the BTP weekly (n=13) or monthly (n=14) were defined as 'Users' (n=27). People who indicated that they hardly ever used it, or that they had used it in the past but had stopped using it (n=21) were defined as 'Discontinued Users'. The participants in the categories 'Users' and 'Discontinued users' completed the questionnaire. Of the third category 'Non-users' only the demographics and reason of non-

usage was noted. Therefore we will compare the first two groups on the constructs from the questionnaire, to see which factors influence use of the BTP.

The demographics for the three user groups are displayed in Table 1. What stands out is that the majority (81%) of the discontinued users are female. Furthermore the mean age of the non-users is higher (*M* =78.7, *SD* =12.9) than that of the users (*M* =76.6, *SD* =13.5) and discontinued users (*M* =74.0, *SD* =15.7). Finally, the majority of participants belong to the somatic units, the user group has the highest percentage (74.1%) in proportion.

3.1 BTP usage

Research question 1. How frequently is the BTP used by residents of the Topaz care homes ?
From the 94 residents, over 51% (n=48) (had) used it now or in the past. From this group over 56% (n=27) still use the BTP on regular basis, the remainder (n=21) discontinued use of the BTP.

Figure 1 illustrates that almost 49% (n=46) of the participants do not use the BTP. The reasons for non-usage can be found in Table 3. These reasons were categorized in the following constructs from the TAM model (Davis, 1989): 'facilitating conditions', 'attitude', and 'perceived ease of use'. Most frequently mentioned was that participants did not know the BTP (21.7%). We categorized this as 'facilitating conditions' because the BTP is available on the care unit, but perhaps not visible enough to the participants. This could also be a reason for residents to forget that the BTP is available. 'Facilitating conditions' also includes the reason that residents want to use the BTP, but need help with it. They are non-users of the device, so we assume this help is not yet offered. Another frequently mentioned reason was 'I do not feel like using the BTP' (19.6%). We categorised this as related to 'attitude'. Another reason that fell into this category was: 'I quickly get tired of the BTP'. There were several reasons that were categorized as 'Perceived ease of use', most frequently mentioned was 'Because of my ethnicity I'm not familiar with the content of most games'(13%). Also in this category residents indicate difficulties with working on the computer and sensory limitations to be reasons not to use the device. All of these reasons were considered barriers in uptake of the BTP program.

Overall there are more discontinued users (n=21) and non-users (n=46) of the BTP, compared to the regular users (n=27) of the device.

Figure 1

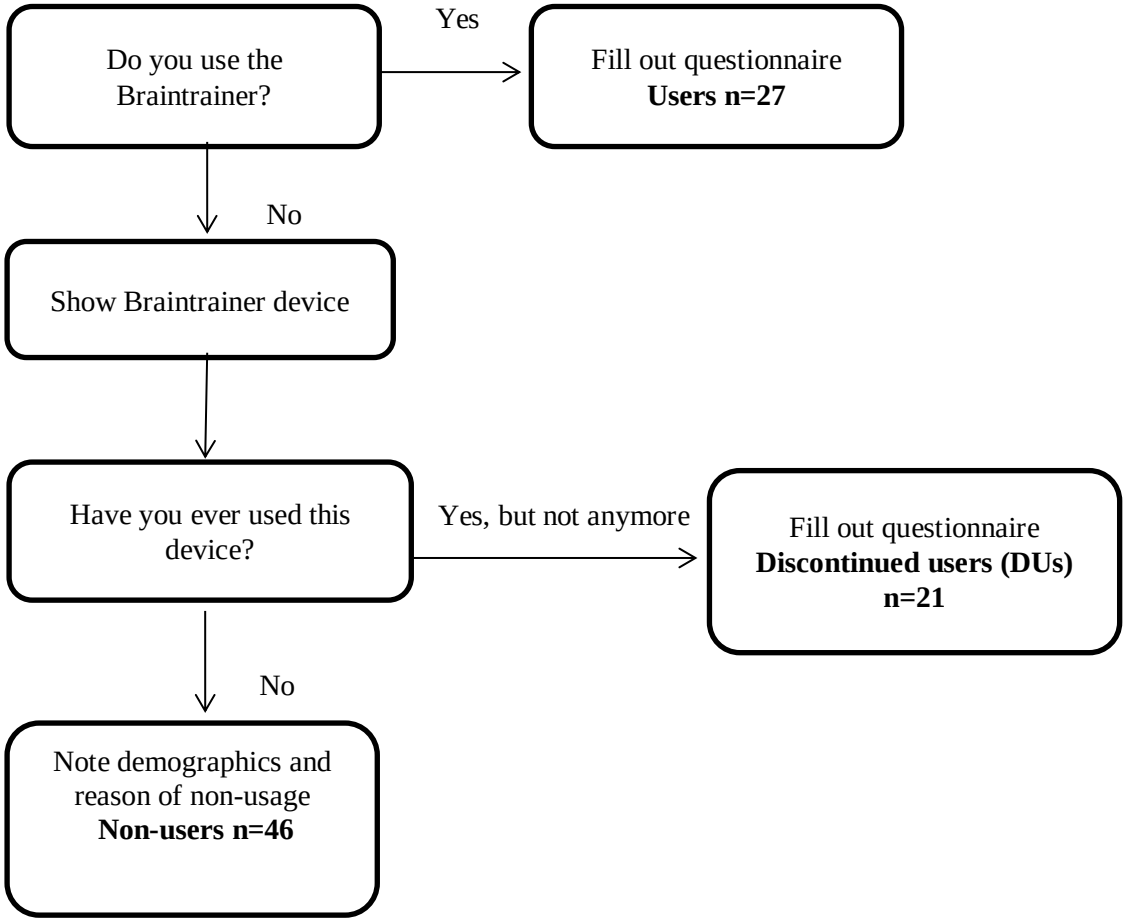

Do you use the Braintrainer?
Yes
Fill out questionnaire
Users n=27
No
Show Braintrainer device
Have you ever used this device?
Yes, but not anymore
Fill out questionnaire
Discontinued users (DUs) n=21
No
Note demographics and reason of non-usage
Non-users n=46

TABLE 3

Categorizing Reasons for Non-usage into UTAUT Constructs

Reasons Non-usage N=46	**Percent**	**Facilitating conditions**	**Attitude**	**Perceived Ease of Use**
I don't know the BTP (n=10)	21.7	X		
I don't feel like using BTP (n=9)	19.6		X	
Because of my ethnicity I'm not familiar with the content of most games (n=6)	13.0			X
I can't work with computers (n=5)	10.9			X
I forget that BTP is available (n=5)	10.9	X		
I want to use BTP, but I need help (n=5)	10.9	X		
I experience sensory limitations in using BTP (n=3)	6.5			X
I find BTP too difficult (n=2)	4.3			X
I quickly get tired of BTP (n=1)	2.2		X	
Total%	100	43.5	21.8	34.7

3.2 Evaluation of the BTP

Research question 2. How is the BTP evaluated by both residents and staff of Topaz? The BTP has tailored its program characteristics specifically to suit the needs of the elderly. We hypothesized that frequent users of the device will evaluate the BTP more positively than users who used the device in the past, but stopped doing so. Visual analysis of Figure 2 shows that the users as well as the discontinued users on average evaluate the BTP with a positive grade, M =7.66 (SD =.78) versus M=6.50 (SD=1.63), on the question 'How do you rate the BTP on a scale of 1 to 10'. The mean grade of the users however is higher than the mean grade of the discontinued users. This difference between the two groups on their evaluation of the BTP is shown to be significant, t (45) = 3.24, p < .01 (Table 5). The hypothesis is accepted, the frequent users do evaluate the BTP more positively than the discontinued users.

With respect to the staff members, it is hypothesized that staff members working on a location where the BTP is used more frequently by the residents, will evaluate the BTP more positively than staff members working on a location where the BTP is used less frequently by

the residents. Table 4 shows use by location and the number of staff and residents that participated in the study by location. Over all locations, the median for frequent BTP use was 63%. By means of a median split it was determined that locations with a BTP use below 63% were scored 'locations with lower frequency of BTP use by residents' (staff n=16). Subsequently locations with a BTP use by the residents equal to or higher than 63% were scored 'locations with higher frequency of BTP use by residents' (staff n=19). With *M*=7.94 (*SD*=1.27) versus *M*=7.31 (*SD*=1.49) the staff members working on locations with higher frequency of BTP use by residents indeed evaluated the BTP slightly more positively. However this difference is shown not to be significant, t (33) = -1.36, $p > .05$ (Table 6), therefore the hypothesis is rejected. There is no significant difference in the evaluation of the BTP between staff members working on locations with higher frequency of BTP use by residents and staff members working on locations with lower frequency of BTP use by residents.

Overall the BTP is on average evaluated with a positive grade by all residents and staff members.

TABLE 4

Frequencies Staff, Residents, Users and Discontinued users per Location

Location	**Number of staff by location**	**Residents by location**	**Frequency of users (percentage by residents)**	**Frequency of DUs (percentage by residents)**
1	10	8	5 (63%)	3 (37%)
2	8	12	7 (58%)	5 (42%)
3	1	3	3 (100%)	0 (0%)
4	2	6	4 (67%)	2 (33%)
5	8	10	4 (40%)	6 (60%)
6	2	4	0 (0%)	4 (100%)
7	1	3	2 (67%)	1 (33%)
8	3	2	2 (100%)	0 (0%)
Total	35	48	27	21

3.3 Differences between groups in terms of user characteristics and environmental factors

Research question 3a. Is there a difference between residents who use the BTP frequently and residents who stopped using the BTP in terms of user characteristics and environmental factors? On the basis of earlier studies (Elliot et al., 2013; Czaja et al., 2006; Namazi & McClintic, 2003), we hypothesized that the two user groups will differ from each other regarding user characteristics and environmental factors. With regard to user characteristics, we expect the users to enjoy being active on the BTP more, find the BTP easier to use, and not only have a higher BTP self-efficacy but also a higher general computer self-efficacy, and finally have less computer anxiety, than the discontinued users. Closer inspection of the distribution of answers of participants (Figure 2) showed that users appeared to rate the BTP more positively on 'perceived enjoyment', 'BTP self-efficacy' and 'computer anxiety'. A series of t-tests and Pearson's Chi squared tests show that there were indeed significant differences between the two groups on some of these factors (Table 5). Given the number of performed t-tests, a Bonferroni correction for multiple testing was executed, which resulted in an alpha level of $p < .004$ to test significance. There was a significant effect for 'perceived enjoyment', t (31) = -3.96, $p < .001$, where the users (M =1.78, SD = .58) enjoyed being active on the BTP more than the discontinued users (M = 2.71, SD = .96). Conversely, there were no differences in 'perceived ease of use' (t (45) = -1.28, p = .208) and 'computer anxiety' (t (46) = .78, p = .439). Interestingly enough there was a significant difference between the two groups on 'BTP self-efficacy' (t (46) = -3.25, p = .002), but not on 'general computer skills' (t (46) = 1.07, p = .291). In other words, users indicate that they can manage better on the BTP than discontinued users could, whereas users and discontinued users both give similar ratings to their general computer skills proficiency. With regard to demographics, there were no significant differences between the two groups.

Concerning environmental factors, we expected users to experience a more facilitative environment than discontinued users. In contrast to our expectation, The Pearson Chi squared tests showed no significant differences between the groups on 'facilitating conditions 1' (χ^2 (2) = 9.75, p = .008) as well as on 'facilitating conditions 2' (χ^2 (2) = 3.53, p = .171). Furthermore, we expected users to be stimulated more often by staff or family in using the device. Consistent with this hypothesis, there was a significant difference between the groups

on ‘social influence’ (t (46) = -6.91, $p < .001$), with users indicating more often that they felt stimulated by staff and family to use the BTP (M=2.30, SD=.67) versus M=3.90, SD=.94).

Research question 3b. Is there a difference between staff members working on a location with higher frequency of BTP use by residents and staff members working on a location with lower frequency of BTP use by residents in terms of user characteristics and environmental factors? It is hypothesized that staff members working on a location where the BTP is used frequently, will have a higher BTP self-efficacy, will stimulate the residents more often in using the BTP and will experience the BTP to have a more positive effect on social interaction than staff members working on a location where the BTP is used less frequently. The Bonferroni correction for multiple testing with regard to the staff data resulted in an alpha level of $p < .013$ to test significance. Table 6 shows no significant differences between the staff members working on a location with higher frequency of BTP use by residents and staff members working on a location with lower frequency of BTP use by residents in terms of user characteristics and environmental factors, therefore the hypotheses are rejected.

TABLE 5

Differences between Users and Discontinued Users on Demographics, User Characteristics, Program Characteristics and Environmental Factors

	Residents M(SD)		***t*-statistic**	χ^2	**df**	***p***
	Users	D.U.'s				
Demographics						
Age	75.19 (12.66)	74.00 (15.74)	.289		46	.774
Gender	1.48 (.51)	1.80 (.40)		5.42	1	.020
Occupation	1.50 (.51)	1.25 (.44)		2.97	1	.085
Unit	1.26 (.45)	1.38 (.50)		0.81	1	.367
User characteristics						
Perceived enjoyment	1.78 (.58)	2.71 (.96)	-3.96		31	.000*
Perceived ease of use	2.69 (.97)	3.05 (.92)	-1.28		45	.208
BTP self-efficacy	2.15 (.91)	3.00 (.89)	-3.25		46	.002*
General computer skills	3.74 (2.63)	2.95 (2.42)	1.07		46	.291
Computer anxiety	2.44 (1.40)	2.14 (1.23)	.78		46	.439
Program characteristics						
Evaluation	7.66 (.78)	6.50 (1.63)	3.24		45	.002*
Environmental factors						
Facilitating conditions 1	1.56 (.80)	2.14 (1.01)		9.75	2	.008
Facilitating conditions 2	1.44 (.80)	1.90 (.94)		3.53	2	.171
Social influence	2.30 (.67)	3.90 (.94)	-6.91		46	.000*

*= $p < .004$ (2-tailed)

TABLE 6

Differences between Staff members from Locations with frequent use of BTP by residents and Staff members from locations with less frequent use of BTP by residents on User Characteristics, Program Characteristics and Environmental Factors

	Staff members M(SD) on Locations with frequent BTP use	**Staff members M(SD) on** Locations with less frequent BTP use	***t*-statistic**	**df**	***p***
User characteristics					
BTP self-efficacy	2.11 (1.37)	2.19 (.83)	.209	33	.835
Program characteristics					
Evaluation	7.94 (1.27)	7.31 (1.49)	-1.36	33	.183
Environmental factors					
Social influence	2.53 (1.39)	2.31 (1.14)	-0.49	33	.626
Perceived impact social interaction	1.89 (.81)	2.69 (1.01)	2.57	33	.015

*=$p < .013$ (2-tailed)

3.4 Factors influencing BTP usage

Research question 4. Which user characteristics, program characteristics and environmental factors are the strongest related to BTP usage among elderly residents? On the basis of the UTAUT and TAM models we hypothesized perceived ease of use, social influence, facilitating conditions, perceived enjoyment, computer self-efficacy, computer anxiety, computer skills, gender and age to be related to BTP usage.

To answer this question a logistic regression analysis (LRA) was conducted. However there were 13 factors set against the sample of 48 participants, which exceeded the rule of thumb of 15 subjects per predictor. So firstly a Spearman's Rho correlation analysis was conducted to explore which factors correlated significantly with usage, the dependent variable (Table 7). Corresponding with the results from the t-tests, the predictors 'perceived enjoyment', 'evaluation', 'BTP computer self-efficacy', 'social influence' and also 'gender' had significant correlations. Even though 5 predictors is still slightly too many compared to

our sample of 48 participants, we felt it was not warranted to leave out any other predictors. Therefore, the results have to be interpreted with caution. The LRA was conducted, to predict membership to the group of users or discontinued users. Table 8 shows the results of the LRA. A test of the full model against a constant only model was significant, indicating that the predictors as a set reliably distinguished between users and discontinued users (χ^2 (5) = 48.610, $p < .001$). The full model correctly classified 93.6% (92.6% for users and 95.0% for discontinued users) of all cases, as compared to 57.4% for the constant only model, and explained between 64.5% (Cox and Snell R square) and 86.6 % (Nagelkerke R square) of the variance. The Hosmer and Lemeshow statistic was not significant ($p = .937$), which means that our model is quite a good fit. The Wald criterion demonstrates that 'gender' ($p = .049$), 'perceived enjoyment' ($p = .027$) and 'social influence' ($p = .021$) made a significant contribution to predicting which group of users a person belongs to. 'Evaluation' and 'BTP self-efficacy' were not significant predictors.

To answer the fourth research question, we can conclude that user characteristics ('gender' and 'perceived enjoyment') and environmental factors ('social influence') are related to use of the BTP. Being male, enjoying use of the BTP and being stimulated by others to use the BTP increased the likelihood of BTP usage.

TABLE 7

Spearman's Rho Correlations for Usage with User Characteristics, Program Characteristics and Environmental Factors

	Usage BTP (Users/D.U.'s)
User Characteristics	
Age	.002
Gender	-.336*
Unit	-.130
Occupation	.254
Perceived enjoyment	.514**
Perceived ease of use	.172
BTP computer self-efficacy	.456**
General computer self-efficacy	.126
Computer Anxiety	.106
Program Characteristics	
Evaluation	.460**
Environmental Factors	
Social influence	.711**
Facilitating conditions1	.296
Facilitating conditions2	.267

*= $p < .05$, **= $p < .01$ (2-tailed)

TABLE 8

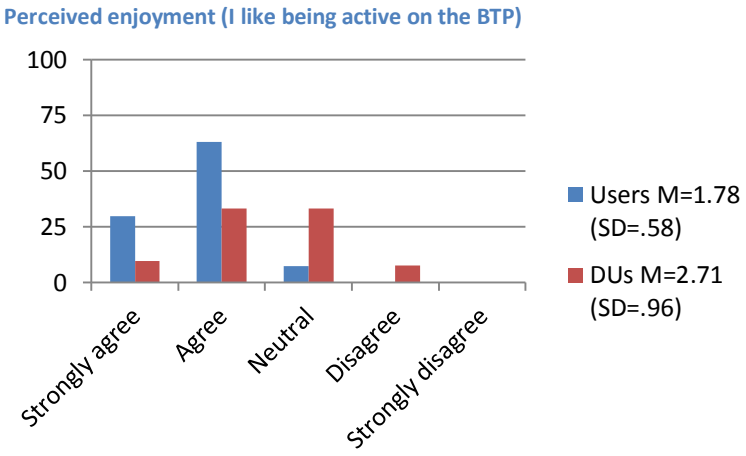
Logistic Regression Analysis of BTP Usage

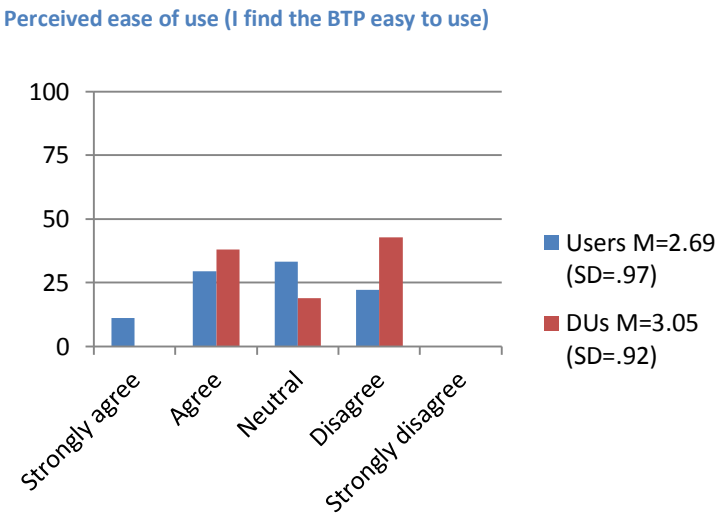
	B (SE)	**Wald**	**Sig.**	**Exp(B)**
Constant	-30.39 (14.52)	4.38	.036	.000
User characteristics				
Perceived enjoyment	3.49 (1.57)	4.91	.027*	32.65
BTP computer self-efficacy	0.93 (1.08)	0.75	.387	2.54
Gender	5.53 (2.81)	3.89	.049*	252.93
Program Characteristics				
Evaluation	0.45 (0.89)	0.26	.614	1.57
Environmental Factors				
Social influence	3.65 (1.59)	5.31	.021*	38.60

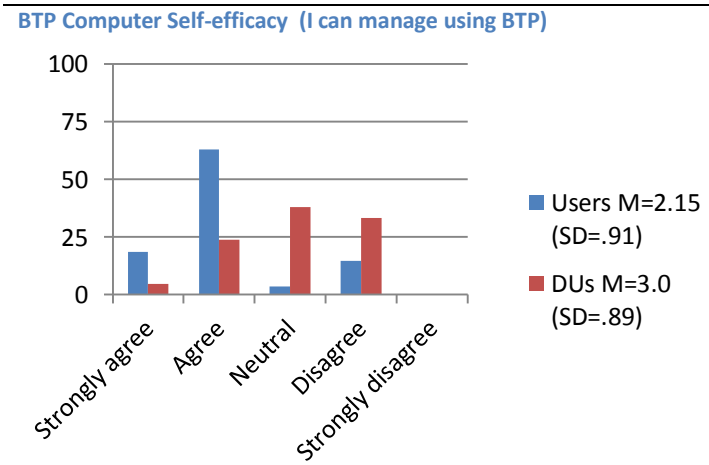
*= $p < .05$ (2-tailed)

Figure 2

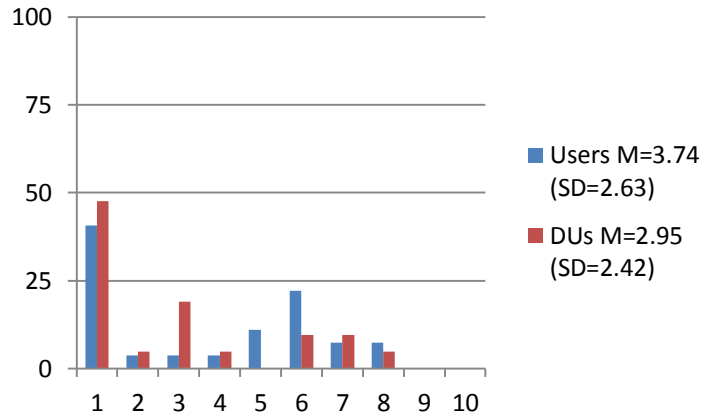
User characteristics



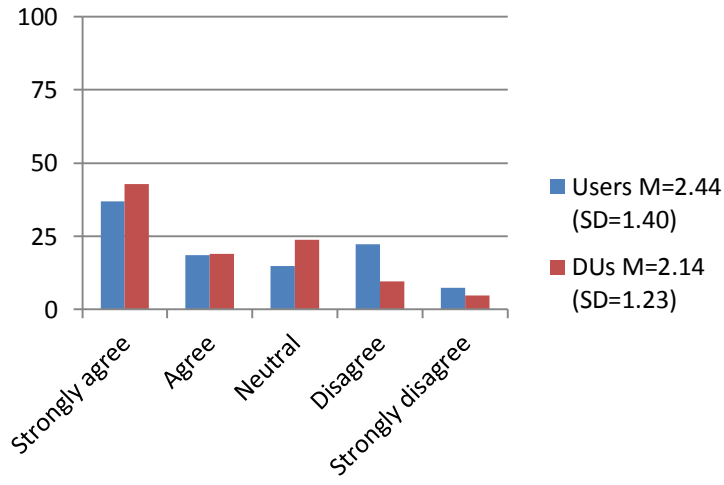




General Computer Skills (How do you rate your computer skills on a scale of 1 to 10, where 10 is excellent)

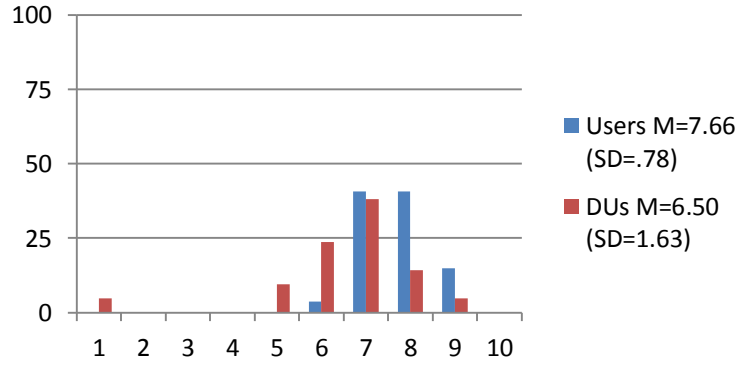


Computer anxiety (I feel apprehensive about using a computer)



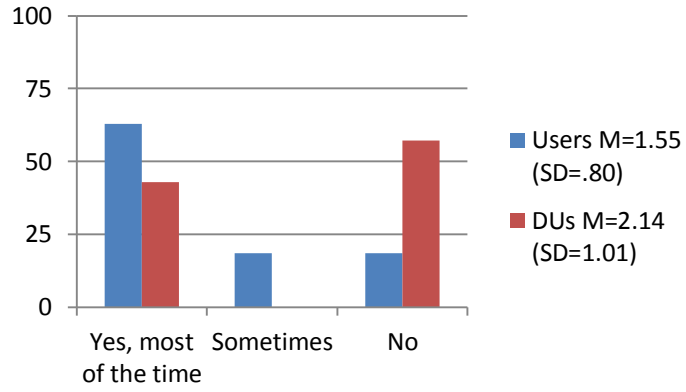
Program Characteristics

Evaluation (How do you rate the BTP on a scale of 1 to 10, where 10 is excellent)

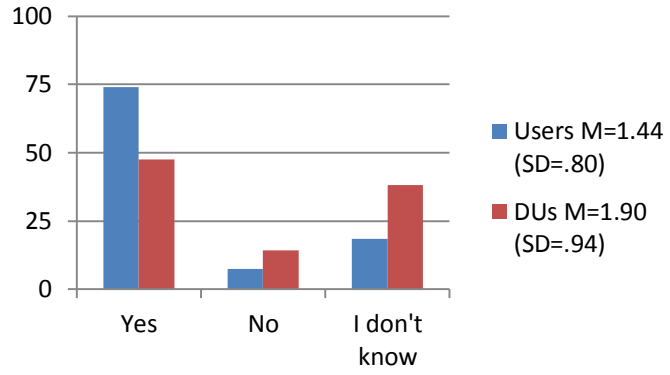


Environmental characteristics

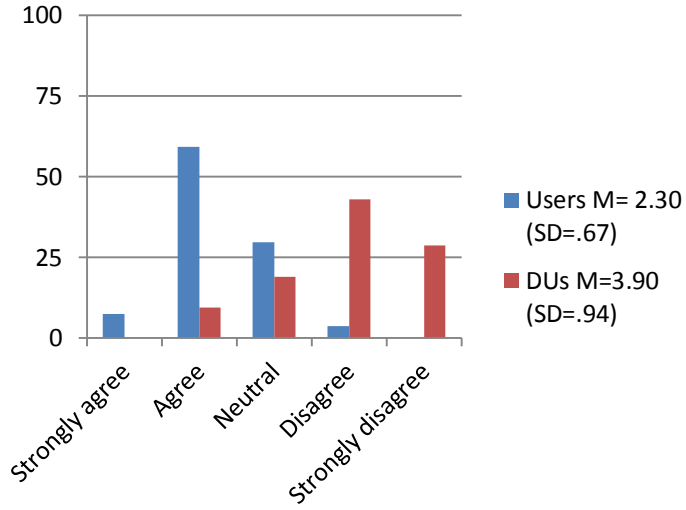
Facilitating conditions 1 (I can use the BTP whenever I feel like it)



Facilitating conditions 2 (When I encounter problems using the BTP, I can ask the staff for help)



Social Influence (Others, like the staff or family members, find it important for me to use the BTP)



4 Discussion

Old age is often associated with age-related cognitive decline. Computerized cognitive training programs can improve cognitive functioning of the elderly people. However these programs suffer from low usage, due to environmental factors, program characteristics and user characteristics. This study examined the use of the Brain Trainer Plus (BTP), a computerized cognitive training device developed for use in nursing homes for the elderly in the Netherlands. The purpose was to examine how frequently the BTP is used in practice and which environmental factors and user characteristics are associated with (non-)usage of the BTP. Shedding light on these characteristics is of importance in order to improve adherence to and optimize usage of future computerized training interventions for the elderly.

4.1 Uptake and usage of BTP

Most CCT research focused on effectiveness and usage in trials, however little is known about uptake and usage of these programs in practice. Therefore the first research question investigated how frequently the BTP is used in practice by the residents of Topaz. The results showed that less than one-third (29%) of the 94 elderly participants actually used the BTP on regular basis. The majority had never used the device (49%) or had discontinued use (22%). This finding supports our notion that there is a reduced uptake and usage of CCT programs in practice. Our result are in line with studies on general computer use among the elderly (e.g., Cody et al., 1999; Namazi and McClintic, 2003), which also report low uptake and high non-usage rates of computer programs in practice. As regards to initial uptake of a computer program Cody et al. (1999) mentioned low social support as one of the main reasons for low uptake. According to Namazi and McClintic (2003) lacking facilitating conditions were very important in determining whether or not people started using a computer program. Correspondingly, in our study we found the social environment to be most important in determining uptake. For example, facilitating *conditions* (43.5%) were mentioned most frequently by the non-users of the BTP when they were asked why they had never used the device. Residents indicated they did not know the device, or they forgot that the BTP was available, and also that they wanted to use the device but needed help with it. The BTP was available on the care units, but it seemed not to be very visible for the residents. This may have to do with the fact that only 2 of the 12 available devices in Topaz care homes had a fixed location in residents' joint living room and were therefore visible and were easily accessible to the residents. Ten of the 12 available BTP devices were kept in the staff room.

Generally the staff has to offer the BTP as an activity to the residents. Considering most of the residents deal with (age-related) cognitive impairments, it is not quaint that the elderly indicated not to know the device or had forgotten that it is available. Although facilitating conditions can serve as a support to stimulate usage, they can also become a barrier, like when there is a hindrance to access the program (Ritterband et al. 2010). This is the case in our study, where the BTP is overall not visible to the residents. Thus, this underscores the importance of a facilitative environment in stimulating initial uptake of computerized cognitive training programs in care homes.

4.2. The influence of program characteristics, user characteristics and environmental factors on usage of the BTP

Ritterband et al. (2010) mentioned several causes for the low usage of computerized interventions, which can be divided in three broad categories: environmental factors which included the setting and context in which the computerized intervention is used, program characteristics including the appearance of the computer program and mode of delivery, and user characteristics which include demographics and, beliefs and attitudes of the user. When usage is mentioned at all in CCT studies, the focus is only on one of these categories. In our study we focused on all three of the categories.

As regards to *program characteristics*, our second research question investigated how the BTP is evaluated by both residents and staff of Topaz. Overall, the BTP was evaluated positively. Frequent users of the device evaluated the BTP more positively, rating the BTP a 7.7 on a ten-point scale, as compared to residents who had used the BTP in the past, but stopped using it ('discontinued users'), who rated the BTP with an average 6.5. This difference was significant and confirmed our hypothesis. With regard to the staff, the staff members working on locations with higher frequency of BTP use by residents indeed evaluated the BTP slightly more positively, than staff members working on locations with lower frequency of BTP use by residents, respectively 7.9 versus 7.3 on a ten-point scale. However this difference was not found to be not significant. Although the program characteristics were designed to suit the needs of the elderly people, still the residents experienced some difficulties. These could partly explain the lower evaluation of the discontinued users and their decision to stop using the device. For example, the residents had difficulties understanding the computer voice asking the questions in all the games, furthermore they experienced the multiple choice categories in most of the games being

difficult to remember, especially the residents from the PG units. Additionally one has to know the Dutch culture and history in order to participate in the different quizzes of the BTP, however a growing number of elderly in the care homes are from a different ethnic background and are therefore not familiar with the old songs or old Dutch sayings and are not able to participate in the quizzes. Earlier research underscores the importance of tailoring computerized training programs to the needs of the elderly (e.g. Bozoki et al., 2013), future computerized program developers have to take into account the changing population in care homes and, as a consequence, different cultural needs and values when developing interventions for the elderly.

The third research question investigated whether there was a difference between the users and discontinued users of the BTP in terms of user characteristics and environmental factors. When looking at *user characteristics*, demographic variables, cognitive factors, physiological functioning, skills, and beliefs and attitudes, are related to usage (Carpenter & Buday, 2007; Czaja et al., 2006; Elliot et al., 2013; Namazi & McClintic, 2003; Saunders, 2004; Venkatesh, 2003). The UTAUT and TAM models emphasized the importance of beliefs and attitudes of the users in predicting the intention to accept and use the new technology. Indeed we found some beliefs and attitudes to be important, users enjoyed being active on the BTP more and experienced a higher BTP self-efficacy compared to the discontinued users, this corresponds to our hypotheses. A reason for this may be that a larger percentage of the users (74%) are residents of the somatic unit compared to the discontinued users (62%). The elderly people from the somatic unit are better cognitively capable to remember the multiple choice answers that form an important part of the BTP games and therefore have more success in answering the questions. Czaja et al. (2006) cited that the more success one experiences, the more one enjoys being active on the device and consequently ones confidence/self-efficacy on the device grows. Along these lines, we also expected frequent users of the BTP to have a lower computer anxiety compared to the discontinued users. However, we found no significant differences between the two groups on computer anxiety. Both groups felt relatively apprehensive in using a computer. Similarly, both groups rated their computer skills as relatively poor. Apparently, using the BTP regularly and having a high device-specific self-efficacy has no influence on the general computer anxiety or skills among the elderly. Because the users knew the BTP, they could easily manage it, but this does not mean they could manage a general computer, therefore they still felt apprehensive with computer use in general. This corresponds with the findings of Yi & Hwang (2003) who

found application-specific self-efficacy to be a stronger determinant of usage than general computer self-efficacy. Additionally, in contrast to our hypothesis, we found no differences between the users and discontinued users on perceived ease of use as overall both groups found the BTP quite easy to use. In sum, when looking at user characteristics, we found no significant differences between the groups on demographics, regarding cognitive factors a larger percentage of the users where from the somatic unit, with better cognitive capabilities. Furthermore when looking at beliefs and attitudes, it is notable that discontinued users evaluated the BTP relatively positive, they found the BTP fairly easy to use, they did not feel more apprehension in using a computer compared to the users and their computer skills were no better or worse than those of the users, but still they discontinued use. It is important to uncover why the residents discontinued use in order to improve adherence of future computerized training interventions. We already mentioned program characteristics to partly explain the discontinued use.

Environmental factors which included the setting and context in which the computerized intervention is used, could also be an explanation for the discontinued use. In agreement with our hypothesis, we found social influence to affect BTP usage positively. Users indicated being stimulated/encouraged more often by staff members or family in using the device compared to discontinued users, they felt less stimulated by staff members or family and maybe therefore stopped using the BTP. This corresponds with the research of Mohr et al. (2011) who argue that human support will increase adherence through supportive accountability. This means that the social presence of another human being will increase adherence, especially when the other human being is seen as trustworthy and experienced on the task. Wagner, Hassanein and Head (2010) argued that supportive personnel could highlight the benefits of the program and therewith increase the motivation of these elderly in using the device. In order to being able to stimulate residents, it is important for staff and family members to know the beneficial effects of the computerized cognitive training program on residents. Therefore future studies related to computer usage of the elderly should include information sessions to staff and/or family members on the beneficial effects of computerized intervention programs and the need to encourage the elderly people to use such a program.

Along the same lines, facilitating conditions were hypothesized to also be influential in determining (non)usage of the BTP. However, we found users not to experience a more facilitative environment compared to the discontinued users, therefore we had to reject this

hypothesis. The lack of findings may also be partly attributable to ambiguity of the questions regarding facilitating conditions in the questionnaire (Appendix A, questions 8 and 9). Residents were asked to respond to the following statements: *8. 'I can use the BTP whenever I feel like it'* and *9. 'When I encounter problems using the BTP, I can ask the staff for help'.* As mentioned earlier, most of the BTP devices are not visible or easily accessible by the residents, staff members have to offer the BTP to the residents. Therefore the residents cannot use the BTP whenever they feel like it, although they can ask for the device, but cognitive impairments often prevent them from doing so. Concerning question 9, the residents can indeed ask the staff for help with the BTP, but when conducting the research it became clear that the BTP is often used as a group activity, where individual help with the device is barely needed. At the time of construction of the questionnaire, this information was not known. Reduced construct validity may have influenced our results regarding facilitating conditions. However due to the lack of visibility and ease of access of the BTP the facilitating conditions became a barrier to use, corresponding to Ritterband et al. (2010).

In sum, in accordance with the research of Ritterband et al. (2010) we indeed found program characteristics, user characteristics and environmental factors to influence usage of computerized interventions. Although the program characteristics were designed to suit the needs of the elderly people, still the residents experienced some difficulties. Therefore, based on our findings, the program characteristics need further modifications. With regards to user characteristics, beliefs and attitudes were found to influence usage most. When looking at environmental factors, social influence was found to be most important and positively influenced usage. Since there is no previous research investigating influence of these three characteristics on CCT programs, our findings should be further investigated in more extensive studies.

4.3 Findings regarding staff members

Several studies have emphasized the importance of a supportive environment to increase adherence to the computerized intervention (Carpenter & Buday, 2007; Czaja et al., 2006; Elliot, Mooney, Douthit & Lynch, 2013; Moher et al., 2011; Nägle & Schmidt, 2012; Saunders, 2004). To our knowledge no prior research exists incorporating the opinion of staff members in evaluating use of a CCT program for elderly residents in a care home. Therefore in this study we take into account the opinion of the staff regarding the BTP. Research question 3b investigated whether there is a difference between staff members working on a

location with higher frequency of BTP use by residents and staff members working on a location with lower frequency of BTP use by residents in terms of user characteristics and environmental factors. We hypothesized that staff members working on a location where the BTP is used more frequently by the residents , will have a higher BTP self-efficacy, will stimulate the residents more often in using the BTP and will experience the BTP to have a more positive effect on social interaction than staff members working on a location where the BTP is used less frequently by the residents, in line with the research of Mohr et al. (2011), Ritterband et al. (2010) and Wagner et al. (2010) . Surprisingly, our hypotheses failed to reach significance, but since to our knowledge there is no previous research with staff members regarding this topic, we cannot compare our results. The frequent users of the BTP experienced being encouraged by staff to use the BTP more often, therefore we expected to see a significant difference between staff members on the higher frequency of use locations versus the lower frequency of use locations. There could be several causes for the non-significant findings: the sample of staff members was too small to make meaningful comparisons. Also 'convenience sampling' could have influenced the results. All staff members present were asked to fill out the questionnaire, however most of them were not aware of the content of the study and may have given socially desirable answers. Also, all of the staff members who participated knew the BTP, but not all of them have worked with the BTP. Therefore they may have not been capable of responding to the questions in the questionnaire. Furthermore our division of the staff sample on basis of a median split may have affected the results. Research investigating how staff members can contribute to actual usage of CCT programs for elderly in care homes, is needed.

4.4 Factors influencing BTP usage

The UTAUT model (Venkatesh, 2003) and its predecessor the TAM model (Davis, 1989) have shown behavioral intention to be important in the degree to which an individual tends to use and accept a new technology. Behavioral intention is influenced by perceived usefulness/performance expectancy, perceived ease of use/effort expectancy, and in the UTAUT model social influence and facilitating conditions are added. Additional factors in the model include perceived enjoyment, computer self-efficacy, computer anxiety, computer skills, gender and age (Venkatesh, 2015). The final research question investigated which of these factors is the strongest related to BTP usage among elderly residents. According to the logistic regression analysis we conducted, perceived enjoyment, social influence and gender were the factors strongest related to use. Perceived usefulness was not included in the study,

because it is considered a more important determinant in usage of systems related to productive use, like in a work setting (Van der Heijden, 2004). However perceived ease of use was considered the strongest predictor in hedonic systems, where pleasure is the main objective, this is the case with the BTP. Still we found no relations of perceived ease of use with BTP usage. Of the 4 major determinants of the UTAUT model, we only found social influence to be related to usage. And of the additional factors only gender and perceived enjoyment were found. Although the UTAUT and TAM models are influential in user acceptance of new technology, they have been modified several times (Venkatesh, 2015). Since these models are often used in organizational context, there is still room for modification especially in the field of elderly user acceptance of technology, where for example cognitive abilities could be included in the model as a factor influencing acceptance and use of new technology. Another reason for the limited findings may be the intention-behavior gap (Sheeran, 2002). The UTAUT and TAM model emphasize the importance of intension to use a new technology and its determining factors, however in this study we look at actual usage behavior. Intensions are indeed formed prior to the behavior, but that does not automatically mean that the desired behavior will follow. This is especially the case with elderly people, who face all kinds of limitations, and are therefore not always able to transform intention into behavior.

The purpose of this study was to examine how frequently the BTP is used in practice and which environmental and user characteristics are associated with (non) usage of the BTP. Overall the BTP suffers from low usage. Less than 30% of the residents use the device frequently. Social influence was the environmental factor associated with BTP usage. This is in line with previous studies which emphasized the importance of a supportive social environment (Czaja et al., 2006; Elliot, Mooney, Douthit & Lynch, 2013; Nägle & Schmidt, 2012; Saunders, 2004). The attitude of the staff members of care homes towards the CCT program could influence use of the program. When looking at the staff members in this study (n=35), in general over 70% evaluate the BTP with a score of 7 or more and almost 70% claim the BTP to promote social interaction between the residents, so they are quite positive about the device. Still the BTP suffers from low usage. Future studies should investigate the attitudes and behaviors of the staff regarding CCT programs in care homes in order to learn more about their influence on usage.

Perceived enjoyment was one of the user characteristics we found in this study associated to BTP usage. Regarding perceived enjoyment an elderly female resident of a

psychogeriatric care unit responded: “I really enjoy being active on the BTP. All day long I am confronted with how much I forget, but when I do the quizzes on the BTP I notice how much I still know.” This quote is in line with the research of Van der Heijden (2004) who states that user acceptance of technology is determined by intrinsic and extrinsic motivation: “An extrinsically motivated user is driven by the expectation of some reward or benefit external to the system-user interaction. An intrinsically motivated user is driven by benefits derived from the interaction with the system per se” (p. 697). From the definition of perceived enjoyment (“the extent to which the activity of using the computer is perceived to be enjoyable in its own right, apart from any performance consequence that may be anticipated" (Davis et al.1992, p. 1113) it is clear that, it focuses on intrinsic motivation. More research is needed regarding perceived enjoyment, since it could be influential in technology acceptance of older users, with fun rather than productive use being the main objective for using technology. Future program designers should try to make the CCT program as enjoyable as possible for the participants in order to stimulate use, by for example personalising the content or incorporate interactive options. The BTP has this option, but overall they are not used by staff members and residents do not know how to use them.

Gender was the second user characteristic we found to be associated with BTP usage. According to Karavidas et al. (2005), elderly males and females use the computer about equally often, but the females report more anxiety and less computer knowledge. This is in line with our findings, in the group of users there are about equal percentages of males (52%) and females (48%). However when looking at the group of discontinued users, 81% was female. Hence they are more likely to discontinue use of the program. Future investigators should try to stimulate females to adhere to the program by for example giving them more attention, so they can experience more success and therefore their confidence on the device grows and computer anxiety is reduced.

4.5 Strengths and limitations

Previous research on CCT programs mainly focused on the effectiveness of such programs. Not much research exists on factors influencing the uptake and usage of such computerized programs in the field, the present study tried to make a first attempt. For this attempt the BTP was used, since this is a widely used CCT program in care homes in the Netherlands and had not yet been evaluated. In addition, we did not only investigate user characteristics and environmental characteristics, but also investigated the opinion of the staff

members of the care home, because of ample evidence that the (social) environment influences use. To the best of our knowledge, this has not been done previously. Unfortunately, we found no significant results when comparing staff members from locations with frequent use of the BTP by residents to staff members from locations with lower use of the BTP by residents. This may be related to a number of weaknesses our study suffered from.

Firstly, since the residents suffered from different stages of cognitive decline, this may have influenced their answers on the questionnaire. They may also have given socially desirable answers, this also applies for the staff members. This may have had implications for the reliability of our results and therefore they have to be interpreted with caution. Further research could benefit from collecting objective data regarding usage (e.g. log-in counts) from the computerized device, next to the questionnaires for the participants. Secondly, the low construct validity of some questions in the questionnaire and the convenience sampling may have reduced validity. Also the study is carried out within the specific setting of Topaz care homes and uses a convenience sample, this complicates the generalizability of the results and therefore reduces external validity. There are also limitations regarding measurement validity. Self-constructed questionnaires with single question items were used, based on the TAM model. More extensive questionnaires are needed in future research in order to get well-grounded results. Thirdly, the sample was too small, the assumption of the logistic regression analysis regarding magnitude of sample size was not met. Lastly, this is a cross-sectional study, so it is not possible to look at long term effects. Cohort-effects may be of influence, current elderly may be hesitant in using the BTP, however since younger cohorts of elderly are more used to computers, low usage may not be a problem then.

4.6 Directions for future research

Several recommendations for future research were already mentioned. Overall research is needed on the actual uptake and usage of CCT programs in practice. This study already mentioned barriers in uptake, more extensive investigation is needed, since uptake determines usage. Since the social environment is an important factor in uptake and usage of technology by the elderly, observational studies are needed to investigate which behaviours of staff members influence usage. Furthermore, more research on perceived enjoyment is needed, as it may be an important factor in elderly user acceptance of technology. Research on extending UTAUT and TAM models with determinants of use concerning a growing number of elderly technology users is needed. Also it is important to investigate which user,

program and environmental factors are related to use in e-health interventions in general, since reduced uptake and low usage is a known problem of these programs. Additionally, the current study had a cross-sectional design, however longitudinal studies are needed to understand user acceptance of technology in long term. Since this study has shed a light on factors related to usage, future studies can incorporate these findings and begin with investigating effectiveness of the BTP regarding cognitive functioning and well-being of the elderly people.

5 Conclusion

This study investigated factors influencing the uptake and usage of computerized programs in the field, since previous research on CCT programs mainly focussed on the effectiveness of such programs in trials and not much is known regarding usage of such programs in practice. For this attempt the BTP was used, since this is a widely used CCT program in care homes in the Netherlands and had not yet been evaluated. Similar to research on computer use of the elderly, we found the BTP to suffer from low uptake and usage. Facilitating conditions were mostly mentioned as barriers to uptake. Although the program characteristics of the BTP were designed to suit the needs of the elderly, they faced some difficulties in using the device. Still the BTP was overall positively evaluated by residents and staff members of Topaz. When comparing users and discontinued of the device, we found differences on perceived enjoyment and BTP self-efficacy, the users enjoyed being active on the BTP more and felt they could manage the device better than de discontinued users. Social influence, perceived enjoyment and gender were the user characteristics and environmental factors associated with usage of the BTP. Although this study has some limitations, this was a good explorative endeavour in investigating uptake and usage of CCT programs regarding the elderly in practice. Recommendations for future research include more extensive research on uptake and usage of CCT programs and general e-health programs in practice, observational research regarding behaviours of staff members in care homes which could influence usage of computerized programs by the elderly residents, and research on extending the UTAUT and TAM models with determinants regarding use of elderly technology users. These recommendations are done in order to improve adherence to and optimize usage of future computerized programs.

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Appendix A

Onderzoek naar het gebruik van de Brain Trainer Plus™

Universiteit Leiden

Vragenlijst/Structured Interview Brain Trainer Plus voor bewoners

In te vullen door Jovenka

Informed consent

Ik doe onderzoek naar de Braintrainer. Mag ik u een paar vragen stellen voor onderzoek.
☐ ja ☐ nee

Demografische gegevens

Geslacht ☐ man ☐ vrouw

Leeftijd …….

Afdeling ☐ Somatiek ☐ PG

……..

Locatie:

Vragenlijst beantwoord door ☐ Bewoner
☐ Proxy

Aantekeningen:

Vragenlijst Brain Trainer

1. Kent u de Brain Trainer?
   - ☐ ja
   - ☐ nee

2. Gebruikt u deze weleens?
   - ☐ ja
   - ☐ vroeger wel, nu niet meer
   - ☐ nog nooit gebruikt

3. Hoe vaak gebruikt u de Brain Trainer?
   - ☐ Dagelijks
   - ☐ Wekelijks
   - ☐ Maandelijks
   - ☐ (bijna) Nooit

4. Wat vindt u van de Brain Trainer? Geef een rapportcijfer (1=heel slecht, 10 = uitmuntend)
   - ☐ 1
   - ☐ 2
   - ☐ 3
   - ☐ 4
   - ☐ 5
   - ☐ 6
   - ☐ 7
   - ☐ 8
   - ☐ 9
   - ☐ 10

5. Ik vind het leuk om op de Brain Trainer bezig te zijn.
   - ☐ Helemaal eens
   - ☐ Eens
   - ☐ Neutraal/Weet niet
   - ☐ Oneens
   - ☐ Helemaal oneens

6. Ik kan me goed redden op de Brain Trainer.
   - ☐ Helemaal eens
   - ☐ Eens
   - ☐ Neutraal/Weet niet
   - ☐ Oneens
   - ☐ Helemaal oneens

7. Ik vind de Brain Trainer makkelijk in gebruik.
   - ☐ Helemaal eens
   - ☐ Eens
   - ☐ Neutraal/Weet niet
   - ☐ Oneens
   - ☐ Helemaal oneens

8. Als ik op de Brain Trainer aan de slag wil, dan kan dat.
   - ☐ Ja, meestal wel
   - ☐ Soms
   - ☐ Nee, omdat…

9. Als het niet lukt om op de Brain Trainer aan de slag te gaan, dan kan ik hulp vragen aan het verplegend personeel.
   - ☐ Ja
   - ☐ Nee
   - ☐ Weet niet

10. Anderen (verplegend personeel, familie) vinden het belangrijk dat ik de Brain Trainer gebruik.
   - ☐ Helemaal eens
   - ☐ Eens
   - ☐ Neutraal/Weet niet
   - ☐ Oneens
   - ☐ Helemaal oneens

11. Hoe goed kunt u met computers omgaan? Geef uzelf een rapportcijfer (1=heel slecht, 10=uitmuntend)
   - ☐ 1
   - ☐ 2
   - ☐ 3
   - ☐ 4
   - ☐ 5
   - ☐ 6
   - ☐ 7
   - ☐ 8
   - ☐ 9
   - ☐ 10

12. Ik zie ertegenop om met een computer om te gaan.
   - ☐ Helemaal eens
   - ☐ Eens
   - ☐ Neutraal/Weet niet
   - ☐ Oneens
   - ☐ Helemaal oneens

Dit is het einde van het onderzoek.
Hartelijk dank voor uw medewerking.

Appendix B

Vragenlijst Brain Trainer Staf

Universiteit Leiden

1. Wat vindt u van de Brain Trainer? Geef een rapportcijfer (1=heel slecht, 10= uitmuntend)

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

2. Ik weet goed hoe de Brain Trainer werkt.
   - ☐ Helemaal eens
   - ☐ Eens
   - ☐ Neutraal/Weet niet
   - ☐ Oneens
   - ☐ Helemaal oneens
3. Ik stimuleer de bewoners gebruik te maken van de Brain Trainer.
   - ☐ Helemaal eens
   - ☐ Eens
   - ☐ Neutraal/Weet niet
   - ☐ Oneens
   - ☐ Helemaal oneens
4. Ik vind dat het gebruik van de Brain Trainer de sfeer op de afdeling bevordert.
   - ☐ Helemaal eens
   - ☐ Eens
   - ☐ Neutraal/Weet niet
   - ☐ Oneens
   - ☐ Helemaal oneens

☐ Ik geef toestemming voor het gebruik van mijn antwoorden voor onderzoek.

Dit is het einde van het onderzoek.

Hartelijk dank voor uw medewerking.