Seniors' Perspective on Perceived Transfer Effects of Assistive Robots in Elderly Care: Capability Approach Analysis

Completed Research Paper

Amir Talaei-Khoei
University of Technology Sydney
CB11.06.214 Po.Box 123 UTS,
Boradway NSW Australia
amir.talaei@uts.edu.au

Lundy Lewis
Southern New Hampshire University
2500 North River Road Manchester
NH 03106 USA
l.lewis@snhu.edu

Tala Talaei Khoei
Southern New Hampshire University
2500 North River Road Manchester
NH 03106 USA
tala.talaeikhoei@snhu.edu

Amir Hossein Ghapanchi
Griffith University
Engineering Drive, Southport,
QLD 4222, Australia
a.ghapanchi@griffith.edu.au

Suchada Vichitvanichphong
University of Sunshine Coast
Maroochydore, Queensland, Australia
Suchada.Vichitvanichphong@research.usc.edu.au

Abstract

There have been widespread critiques towards the lack of contextual approaches in the adoption theories. This paper argues that independent living plays a significant role in adoption of assistive technologies such as robots among seniors. Therefore, the present article introduces perceived transfer effects as a cognitive process in which elderly realize how assistive robots help them in their functional abilities to empower their capabilities required to live independently. The study conducts qualitative interviews to understand the constructs contributing to the perceived transfer effects of assistive robots from seniors' perspective. The paper demonstrates the potentials of the capability approach in the context of assistive robots for elderly. The paper opens avenues of research in adoption of similar types of assistive technologies among elderly. The article also informs nursing and aged care professionals about the better adoption of robots as an alternative intervention to improve the everyday life of seniors.

Keywords: Assistive Robots, Aged Care, Adoption

Introduction

As the world's population is growing older, the cost of aged care is likewise increasing. In 2012, 6.9% of the world population was more than 65 years old, and this is estimated to increase to around 20% by

2050 (OECD, 2012). One response could be the use of assistive robots to provide efficiencies in elderly care and lower costs.

Previously, assistive robots were defined as robots that can perform physical activities for disabled people (Feil-Seifer and Mataric, 2005). However, there is a body of literature that takes a broader perspective in defining assistive robots, particularly in the context of elderly care. Vichitvanichphong et al (2014, 2013a, 2013b) in a systematic literature review defined assistive robots for elderly as a type of robot or tele-presence technology that not only improve physical and emotional wellbeing of the users but also provide the services that may reduce household work for seniors. With this definition, the term "robot" is used loosely to cover autonomous robots as well as tele-presence technologies (Michaud et al., 2007). Our concept of assistive robots is more related to this later definition.

While there have been several attempts in literature (Bemelmans et al., 2012) and technology (Broekens et al., 2009) reviews to demonstrate the effectiveness of assistive robots towards independent living of the elderly, Tapus et al (2007) believe that one of the major questions that needs be addressed is "What are the circumstances in which elderly people adopt an assistive robot?" Broadbent et al (2009) argues that despite the several technology advancements, the very low rate of success in the use of assistive robots among seniors is due to the lack of adequate attention to the challenges that older people face in adopting such technologies. Wu et al (2014) believes that while the concept of adoption is well-addressed, its utilization in the context of elderly care is still facing grand challenges due to the particular characteristics of the environment in which the elderly live. Our systematic literature review shows that the traditional approaches for technology uptake appear to be less effective for elderly and the empirical findings in the last fourteen years have demonstrated that more context specific theories should be deployed. Vichitvanichphong et al (2014) argues that the elderly adopt assistive technologies that empower their capabilities to live independently. This brought our attention to the *capability approach* (Sen, 1999) that states people adopt an intervention when they perceive its empowerment. However, perceived empowerment is defined (Robeyns, 2005a) as individuals' opinions about the process of converting an intervention (e.g. an assistive robot) to an ability (e.g. physical, visual or cognitive) that make them capable (e.g. in doing daily activities) of achieving what they value (e.g. independent living). This cognitive process is called *perceived transfer effect*. As such, in this paper perceived empowerment has been used equally with perceived transfer effect.

This paper describes a framework grounded in the capability approach and a series of contextual interviews for exploring and explaining the role of perceived transfer effect in adoption of assistive robots to help with the daily independent living of elderly.

Conventionally, "elderly" has been defined as a chronological age of 65 years old or greater. Orimo et al (Orimo et al., 2006) have discussed the differences between those from 65 through 85 years old, referred to as "early elderly" and those over 85 years old as "late elderly" or "oldest old." However, for the purpose of this study "elderly" refers to people of 65 years or older.

The rest of this paper is organized in the following way: The first section presents a systematic review and introduces capability approach as the theoretical foundation for this work. Then, in the next section, we explain the method of data collection and analysis. The next section presents the results. Finally, the last section discusses the results and proposes an alternative framework for adoption of assistive robots among seniors based on the capability approach. This section also presents limitations and future work.

Background

How Effective have Adoption Theories been Used in the Context of Elderly Care? A Systematic Literature Review

Since the literature in adoption of assistive robots is limited and relatively new, a systematic literature review was conducted to evaluate the application of existing adoption theories in the context of assistive technologies. This method has been previously used in (Amrollahi et al., 2013; Li et al., 2013; Najaftorkaman et al., 2015; Vichitvanichphong et al., 2013b).

The review customized the guidelines for systematic review laid down by (Keele, 2007). Springer, Wiley, Since Direct, IEEE, ACM, Scirus, PubMed and Google Scholar were searched using the following search keys:

- Technology AND
- [aged care" OR "aged" OR "aging" OR "senior" OR "old" OR "elderly" OR "elder" OR "older"] AND
- ["adoption" OR "acceptance" OR "use" OR "behavioural intention" OR "behavioral intention" OR "attitude" OR "believe" OR "belief" OR "usefulness" OR "diffusion" OR "user"].

The search considered titles, keywords, abstracts and full texts of papers published since 2000, inclusive. Due to the large number of papers, publications in 2000 and after have been targeted to ensure timeliness of the results.

Among 723,944 papers searched in the above mentioned databases, 420 papers were remaining after analysis of their titles and irrelevant articles were excluded. 138 articles remained after abstract filtering and 104 papers were identified as the final list of relevant papers after reading the full texts. Articles that had one of the following exclusion criteria were removed:

- Did not focus on assistive technologies for aged care
- Did not have any empirical evidence
- The definition of elderly does not fall into 65 years old or greater
- Were in languages other than English
- Were not in the relevant fields or could not be applied to relevant fields
- Were not peer reviewed
- Were not available online

The final list of the relevant papers can be found at the link below: https://onedrive.live.com/redir?resid=7D934CF0AC729F11!417&authkey=!ACWap84EbOEhchE&ithint=file%2cdocx.

Converting Perceived Usefulness to Actual Usefulness: A Process for Seniors' Independency and Quality of Life

It was found that the papers addressing the adoption of assistive technologies among seniors mainly focus on Perceived Independency and Perceived Quality of Life. *Perceived independency* refers to seniors' perception of their ability to live alone. Kiel (2005) believes that using technologies enhances seniors' Perceived independence as they can now shop, pay bills, bank, learn and engage in chat groups. *Perceived quality of life* has been defined as one's cognitive appraisal of his or her overall satisfaction with life which addresses her/his values (Huebner et al., 2004). It was also observed that because of elderly's appreciation to independent living, their perception of their quality of life can be related to how much they see themselves as an independent person (Steele et al., 2009).

The analysis of results in the related papers showed us that the adoption of assistive technologies among seniors and their suitability to the theories are very much related to the context in which the elderly's living situation (senior's perception about living independently or a range of age-related conditions resulting in quality of life) can account for such an extent that perceived usefulness can be converted to actual usefulness. This would accordingly influence adoption research. The usefulness in the relevant set of papers is judged in many cases, and of course not all, in terms of facilitating the independent living of the elderly and their quality of life. However, as discussed in the next section, the theoretical approaches in literature have been facing difficulties to explain this conversion from perceived to actual usefulness.

Adoption Theories and Lack of Sensitivity to the Context

From the 104 relevant papers, the theoretical perspectives used for adoption and the empirical evidence for these theoretical approaches were extracted.

The review identified thirteen theories as theoretical foundations on which the adoption studies in elderly care have been grounded. The major theories used to adopt assist technologies among seniors are

Technology Adoption Model (TAM) (Davis et al., 1989), (Davis, 1989), Diffusion of Innovation (DoI) (Rogers, 1962), and Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003). Other theories have attracted less attention; such as Theory of Reasoned Action (TRA) (Fishbein and Ajzen, 1980), Theory of Planned Behaviour (TPB) (Ajzen, 1991), Seniors' Technology Acceptance Model (STAM) (Conci et al., 2009), Motivation Theory (MT) (Cofer and Appley, 1964), Learning Theory (LT) (Illeris, 2004), (Ormrod, 2012), (Laver et al., 2011), Activity Theory (AT) (Bedny and Meister, 1997), Theory of Disengagement (ToD) (Cumming and Henry, 1961), Parsimonious Technology Acceptance Model (pTAM) (Sharp, 2006), Ubiquitous Computing-service Acceptance Model (UCAM) (Shin, 2010), and Attribute of Technology (AoT) (Jaspars et al., 1983).

This literature review found that 62 studies did not use any theory to explain their results. The 42.8% of papers that did use theories did not justify their empirical findings. This aspect needs further attention by the research community and we may well ask the question "Why are these theories not being used?"

Gary Johns (Johns, 2006, 2001) warns that the lack of context in adoption research can be confusing. We found that the theoretical aspects of the adoption of assistive technologies lack a more specific approach to cater for a senior's contextual situation. For example, seniors' extension to the Technology Acceptance Model (STAM) differentiates between perceived and confirmed usefulness and states that confirmed usefulness follows an early exploration of the technology by the elderly person. However, STAM fails to explain what happens in the exploration stage when the conversion from perceived usefulness to confirmed/actual usefulness occurs.

For instance, the adoption of technologies requires an assessment of the actual usefulness of the technology for elderly in the context of independent living. This has been theorized in the Seniors' Technology Acceptance Model (STAM). STAM introduces the exploratory stage of adoption where perceived usefulness can be converted to actual usefulness by the senior actually trying to use the technology. In many cases, this is applicable to assistive technologies that usefulness can be demonstrated by literally managing the elderly's functional difficulties and conditions. Therefore, this approach would help seniors live independently or as independently as possible.

However, for the technologies such as robots that target the quality of independent life and not functional conditions of elderly, the process of converting seniors' conditions and lifestyle to a useful endpoint is more difficult. However, the change expected from these technologies occurs over the time and cannot be easily demonstrated. This involves garnering the opinions of seniors and how they perceive a technology as being useful or not.

In response to this concern, Vichitvanichphong et al (2014) argues that the elderly adopt assistive technologies that empower their capabilities that they need in order to live in their own home. The term "empowerment" has been defined as any process whereby people can gain increased capability towards the freedom of choice that they may wish for their lives (Cornish, 2006). The concept of capability thus needs further consideration in adoption of technologies such as assistive robots in elderly care as it seems promising.

In this paper, we recommend researchers in this area to pay greater attention to the capability empowerment concept, which leads us to the use of the Capability Approach as an innovative and a fit-to-purpose theoretical foundation in the context of assistive robots.

The Capability Approach and Perceived Transfer Effect of Robotics Technology in Elderly Care

The Capability Approach argues that the empowerment of capabilities essentially provides freedom for people to choose one type of life over others in order to achieve functionings that they value. Capability in this approach has been defined as "what people are effectively able to do and be" (Sen, 1990). "Functionings" is defined by Sen as "what people value" (Sen, 1990). Therefore, one would try to empower her/his capability to be able to choose his own valuable functionings (Robeyns, 2005b). See Figure 1.

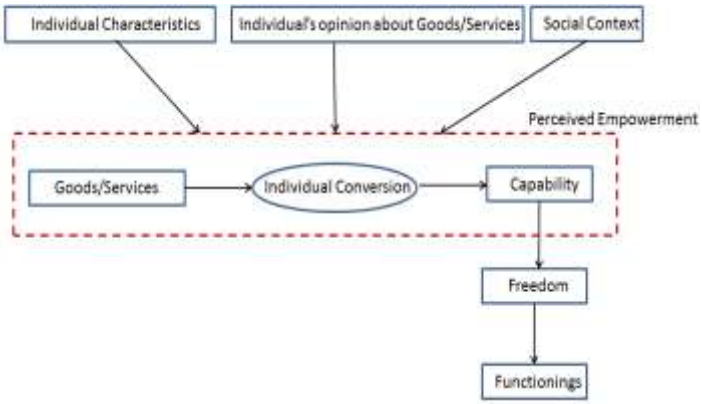

Figure 1 Capability Approach (Sen, 1990) (Robeyns, 2005b)

Looking at the basic model of the Capability Approach (Sen, 1990) consisting of functionings, freedom of choice, and capability, the starting point to use the approach is to realize that independent living is a significant issue among seniors and it is what they value as the type of life that they wish to live.

Moving towards the enhanced model of the Capability Approach proposed by Robeyns (2005) and its applications in adoption of assistive robots among the elderly, perceived empowerment is where the the approach shows promise. In using the approach for adopting assistive robots among seniors, "goods" or "services" refer to assistive robots that can provide support for functional (e.g. physical, cognitive or visual) and non-functional (e.g. knowledge) abilities of elderly. In this approach, individual conversion can be seen as functional and non-functional abilities that are empowered by robots. Elderly persons would adopt an assistive robot if they believe the robot supports their functional or non-functional abilities that empower their capability of doing an everyday activity such as driving. Being able to perform the everyday activity such as driving consequently provides the choice of living independently. Therefore, an elderly person would adopt the assistive robot for the purpose of his/her ultimate goal of an independent life. In other words, the elderly adopt a robot if they can perceive the transfer effect of the technology to improve their capability of doing an everyday activity. For this purpose, a *transfer effect* is defined as the process in which an intervention supports functional abilities of seniors towards the empowerment their capabilities to live independently (Elmes et al., 1992).

The social context has been given special attention in the extended version of the Capability Approach (Robeyns, 2005b) as an influencer on the individual perception of empowerment. See Figure 1. Individual factors refer to human beings capacities, strengths and limitations based on different demographics, abilities and interests. According to the extended version of the capability approach, these characteristics of individuals considerably influence their rejection or acceptance of perceived transfer effect. See Figure 1. The capability approach highlights the role of individuals' opinions on goods and service (Robeyns, 2005b).

Methods

Contextual Interviews

We seek to understand the underlying process in which seniors perceive the effectiveness of assistive robots in their everyday lives. In order to do so, we required seniors participating in this study to be aware of and have the experience with the intervention under the study. Therefore, we opted to conduct contextual interviews with elderly persons who had been introduced to assistive robotic technologies prior to the interview.

A one-and-half hour weekly workshop over five weeks on the use of assistive robots in elderly care was facilitated by one of the authors. The participants were 65 years and older and were interested in the role of robotic technologies in assisting them in their everyday lives. The participants brainstormed about useful behaviors and applications of assistive robots. Where possible, the facilitator implemented prototype behaviors in the robot for further evaluation and critical analysis among the participants. The main aim of the workshop was to introduce the robotic technologies to the elderly. The class included

showing videos, watching movies such as "Her" and "Robot and Frank," reading articles, and demonstrating the capabilities of the robot NAO developed by Aldebaran Robotics shown in Figure 2.

Figure 2 pre-workshop for contextual interviews

The participants were approached by emails or telephone calls individually after the 5-week class for their opinions about the role of assistive robots in their everyday lives. Finally 7 elderly (range 67-86 years; Mean = 72.2; Male = 4) participated in our study.

The study continued to interview new participants until repetition in the results were observed. The interviews took average of 36 minutes. The interviews were audio-recorded. Once they were transcribed by the researcher and double checked, the recorded files were deleted for the sake of anonymity.

Analysis

The analysis of interviews was conducted using Alceste software ("Alceste software," 1986). Alceste divided the interviews into contextual units - equivalent to relevant sentences to a particular topic. The percentage of contextual units classified in the interviews was 61.2%, which means that 61.2% of the interviews were somehow related to common topics. This was a good result for qualitative discussions (Reinert, 1998). The Alceste software then established a data matrix to check for the presence or absence of each word in each contextual unit. Only words that appeared more than four times were retained, based on the recommendation of Pombo-de-Barros (2011). The iterative process of defining classes of words associated with the same context, using the DHC algorithm (Merten et al., 2012), aimed to maximize the x^2 criterion (Reinert, 1998). Alceste could identify the most representative parts of participants' discourses for each topic (x^2 >10.8, significant at the 0.1% level).

However, once Alceste classified the relevant groups of sentences with x^2 >10.8, one of the authors coded different groups identified by Alceste into the constructs of the capability approach given in Figure 1. These represent the findings presented in Tables 1 – 5.

During the analysis of the interviews, it was noticed that participants had expressed some emotions during the interviews. Therefore, the Plutchik's (1984) theory of basic emotions was used to analyze the interviewees' emotional expressions. This theory is one of the influential classification approaches for general emotional responses. Plutchik chose eight primary emotions - anger, fear, sadness, disgust, surprise, anticipation, trust, and joy. Plutchik argues for the primacy of these emotions by showing each to be the trigger of behavior with high survival value, such as the way fear inspires the fight-or-flight response. Plutchik has comes up with a model of combining different basic / non-basic emotions to create another emotion. This model was used to analyze the emotions that the participants in this study expressed during the interviews.

Results

Seniors value their independent living

Our study shows that elderly like to live in their place independently because they think that can improve their competence and own the way they live although not be as perfect as it used to be. They also mentioned that they believe living with others makes them uncomfortable and will sooner or later lead to arguments. They also mentioned how sometimes they struggle to live alone but they still like to be independent. In summary, we found seniors value their independent lives, although it comes with its difficulties. See Table 1 .

In this table, the column for the sample statement is one of the sentences that Alceste has identified as relevant contextual unit (sentence) to the findings in the first column. The last numerical column presents x^2 criterion (Reinert, 1998) expressing the significance level (x^2 >10.8, significant at the 0.1% level).

Findings	Sample Statement by Participants	Gender	Age Range	Retirement Status	Independent Living Status	x^2
Home as a significance of being competent.	*"To me, it means I'm not too old and still healthy. I don't care what people say."*	M	<= 85	Not retired	At home alone	17.1
	"We [me and my partner] want to push ourselves to stay at our house. We have been here for years. I don't want to sit down in one of those old people villages [aged care settings] and get sick."	F	> 85	<= 5 years	At home with the partner	12.9
	"Since I moved here [serviced aged care setting], I feel there isn't much for me to live."	F	<= 85	<= 5 years	At aged care setting	19.6
Owning own life	*"We [me and my partner] do things in a way that we choose. Even if we can't manage ourselves like we used to, it's still our life."*	M	<= 85	<= 5 years	At home alone	15.4
	"When I live here in my house, I do what I want and don't need to wait for anyone to do what I feel like to do."	F	> 85	<= 5 years	At home with the partner	13.1
Peace of mind and no argue	*"When someone else does your things, in some stage you might not agree with what they do. Then you have to argue"*	F	<= 85	<= 5 years	At aged care setting	12.2
Struggling with the housework	*"I used to cook much faster. Now, it takes me so long and sometimes I forget what I want to do. But, I say to myself that I can manage it."*	F	> 85	<= 5 years	At home with the partner	11.9
	"It is hard to take care of the garden or move things around. I can pay someone to come and do all these but then I'll feel I can't manage myself anymore and I don't like that feeling."	M	<= 85	> 5 years	At home alone	16.2

Table 1 Seniors Value their independent living.

Seniors think robots can contribute to independent living, a.k.a. perceived transfer effect of robotics technologies in elderly care

The participants were asked that how they think that assistive robots can help them to live independently. In their answers they focused on the support that robotic technologies could provide for their functional and psychological abilities, which in turn would give them capabilities towards independent living. See Table 2.

Findings		Sample Statement by Participants	Gender	Age Range	Retirement Status	Independent Living Status	x^2
Support	Capability						
Physical support	Housework	"They [robots] can help me to clean the pool. I don't need to pay for it. I've even seen it on TV that they can also do all the gardening."	M	<= 85	> 5 years	At home alone	13.7
		"A robot that can carry stuffs for me would be good. When I go shopping it can carry the trollies."	F	> 85	<= 5 years	At home with the partner	14
	Mobility	"I think robots can help me to move my wheelchair. One of my friends has one of motor ones. But they are hard to control. The robots can do that."	M	> 85	<= 5 years	At home alone	13.5

		"I saw in the news that in England, they are testing a car with a robot driver. I would love to have a car like that. Then I don't need to wait that my son comes and drives me. He is busy."	M	<= 85	> 5 years	At home alone	15.1
Visual support	Reading	"I would like to have a machine that can read for me. I used to read a lot but these days my eyes get tired quickly."	F	<= 85	<= 5 years	At aged care setting	11.7
		"There are lots of interesting things on the internet. I know how to use internet but my doctor said to not look at monitor too long. The robots can help me in that."	F	> 85	<= 5 years	At home with the partner	15.3
Memory support	Remembering	"In the morning I plan myself but then I forget. I want to tell the robot what I want to do and then it reminds me. It has to be around that I can hear it."	M	> 85	<= 5 years	At the aged care setting	12.8
		"I forget to take my medicine. My son always blames me for that. Why not these robots remind me of the pills that I need to take?"	M	<= 85	> 5 years	At home alone	11.7
		"Sometimes, I tell my friend that I'm going to call him but I start watching TV and it just goes out of my mind. It would be a good idea that the robots have this call function that I can set and it calls."	M	> 85	<= 5 years	At home alone	16.3
Psychological support	Interactions	"I always wanted to have a cat. I can't afford them anymore, lots of things to do. I saw that video and I don't mind to have something that feels like a cat and I can pet it. It feels good, especially when I'm lonely."	F	<= 85	<= 5 years	At aged care setting	14.5

Table 2 How assistive robots can help elderly in their independent living.

Seniors' characteristics influence the perceived transfer effect of robotics technologies in elderly care

To be able to perceive the transfer effect of assistive robots, seniors think it is required to be technically experienced and be able to learn new things and also be cognitively competent. It was mentioned that the robots do not need extended vision or physical abilities that elderly might not have; See Table 3.

Findings	Sample Statement by Participants	Gender	Age Range	Retirement Status	Independent Living Status	x^2
Technical Expertise	" … you know if you can't work with the robots, you won't get their benefits. I found them hard to start. You need to be very good in these things [technical]."	M	> 85	<= 5 years	At the aged care setting	17.7
Learnability	"If I can't learn it [robot], It's not for me then."	M	<= 85	> 5 years	At home alone	12
	"Robots can do lots of things for us, but we need to learn how to operate them and that's not easy. So at the end of the day, if we don't learn them or if we can't learn then, they will be useless."	F	<= 85	<= 5 years	At aged care setting	13.8
Functional conditions	"I found it hard to remember the instructions, and then you know I can't work with the robots. So, I'm not sure it would help me."	F	<= 85	<= 5 years	At aged care setting	15.1
	"I don't think, I'll have any problem to physically manage the robots. They are not big."	M	<= 85	Not retired	At home alone	12.5
	"The buttons are usually in a good size, so won't be a problem to see them."	F	> 85	<= 5 years	At home with the partner	11.7

Table 3 Seniors' Characteristics and Perceived Transfer Effect

Seniors' opinions about the robots influences perceived transfer effects

The elderly believe that the robots are fun and this influences their opinion about the transfer effect. However, the fact that they are frustrating and confusing may have a negative impact on their opinion. They also mentioned that robots could reduce the challenges of their life, where such challenges are perceived by seniors as harmful. See Table 4.

Findings	Sample Statement by Participants	Gender	Age Range	Retirement Status	Independent Living Status	x^2
Frustrating	"… frustration on getting it [robot] to work … [may influence my opinion]"	F	> 85	<= 5 years	At home with the partner	11.3
Confusing	"There are lot of functions and instructions that are confusing and of course without them the robots are just toys."	M	<= 85	> 5 years	At home alone	12.9
Fun	"… interesting thing to have. They are cute and playful."	F	> 85	<= 5 years	At home with the partner	17.3
Challenging	"They [robots] might be also harmful, because they make me lazy. For example, if they always remind me everything then I won't try to remember anything."	M	<= 85	> 5 years	At home alone	16.4

Table 4 Seniors' Opinion about the robots and Perceived Transfer Effect

Social context and perceived transfer effect of robotics technologies in elderly care

The elderly believe that the social context influences their opinion about the transfer effect. For example, they might perceive robots as toys. They also mention that their thoughts of the transfer effect of assistive robots are influenced by their friends and relatives. See Table 5.

Findings	Sample Statement by Participants	Gender	Age Range	Retirement Status	Independent Living Status	x^2
Toys for kids	"If you don't exactly know what robots are and what they can do for you, you might say that these are just toys for kids."	M	<= 85	Not retired	At home alone	15.9
Recommendations from Friends and Relatives	"I know that I shouldn't listen to others but I have a friend that I talk to her about everything and I think she would have some influence on me. It is not intentional."	F	<= 85	<= 5 years	At aged care setting	13.4

Table 5 Social Context and Perceived Transfer Effect

Summary, Discussion and Future Work

The paper benefits from a systematic literature review on adoption of assistive technologies among seniors. The review found that Seniors' Technology Acceptance Model (STAM) argues that seniors convert their perceived usefulness of a technology to an actual usefulness through a cognitive process. However, STAM like many other technology adoption theories lacks the context for elderly and fails to explain what happens in the conversion process. This review revealed that technologies that have been adopted among seniors mainly targeted the elderly's perception about either their independent living or their quality of life when living independently. However, the change in the perception can be expected over time when the assistive technology such as robots targets seniors' life style. This leads to the difficulty of converting perceived usefulness to actual usefulness. The present paper focuses on empowerment of capabilities required for independent living as a key for this cognitive conversion process.

In this study, the use of the Capability Approach as an innovative lens for adoption of assistive robots among seniors has been proposed. The paper demonstrates the empirical potentials of this approach through in-depth qualitative interviews that examine the seniors' perspectives on the transfer effects of assistive robots. As mentioned earlier the second phase of analysis was conducted by one of the authors and was involved the coding of the relevant contextual units found by Alceste into the capability approach model. These codes were grouped as findings presented in the first column of Tables 1 -5. As such, Figure 3 presents the potential utilization of the capability approach in the context of assistive robots from elderly's perspective. The items in each group present the findings found in Analysis and expressed in Tables 1 – 5.

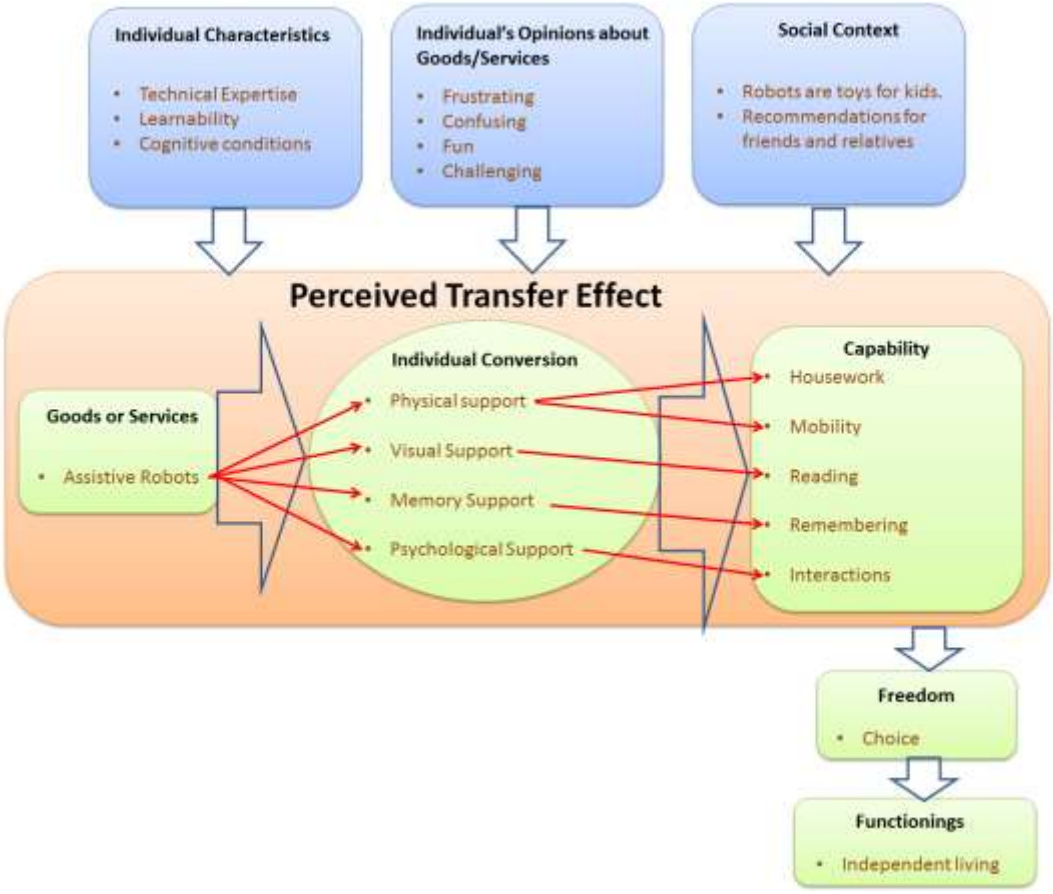

Figure 3 Seniors' Perspective on Perceived Transfer Effects of Assistive Robots in Elderly Care: Capability Approach Analysis

Although we acknowledge that this study has too few subjects to generalize the findings, the paper is to make a proof of concept for a bigger trial discussed in the section for limitations. However, the concept studied in this paper has demonstrated a potential that if older adults perceive the transfer effect of assistive robots on the capabilities that they require for their independent daily living, they might adopt these technology. The elderly did not actually adopt the assistive robots but they were speculating about the usefulness of robots based on the 5 weeks of training. The study found that the transfer effects of assistive robots from the seniors' perspective are to convert the functional (physical, visual and memory) and non-functional (psychological) support provided by robots to everyday life capabilities (housework, mobility, reading, remembering and interactions, etc.). It also found that their perception is related to their characteristics, their opinion about the robots, and the social context.

Our results are consistent with Bedaf et al. (Bedaf et al., 2013) that define seniors' independent living as not doing everything oneself but having control over it and choosing what to do. Independence therefore is very much related to the notion of people's freedom of choice used in the capability approach. Seniors highly value their independent living. Using the Capability Approach in our study, we suggest that seniors

would adopt assistive robots if they believe that using the technology can improve or maintain their capability for performing an everyday activity which makes it possible for them to live independently. However, we acknowledge that this is subject to the limited number of participants to generalize.

These results are in the contrast with (Gill et al., 2002) indicating that the physical and visual ability to use the technology is essential for technology acceptance. Although we acknowledge this concern, our results show that the design of robotic technologies is appropriate for visual and physical abilities of elderly. Another barrier for seniors to adopt a technology is the fact that a significant number of the elderly are facing some sort of decline in their memory performance, which would directly impact their skills needed to use technologies (Czaja and Lee, 2007; Czaja et al., 2006). This has been demonstrated also in our findings.

Interestingly, our results are in-line with the literature that older adults' opinions about the technology matters (Theng et al., 2012) (Heerink et al., 2008), (Conci et al., 2009) (Heerink et al., 2010) (Gamberini et al., 2006). The literature also acknowledges our results implying the influence of individual characteristics (Wilkowska and Ziefle, 2009).

Social influence plays an important role in decision making (Braun, 2013) and particularly for technology adoption among seniors (Klamer and Ben Allouch, 2010), (Lam and Lee, 2006). For example, our results show the influence of friends and relatives as well as social norms saying robots are toys for kids.

Theoretical and Practical Implications

The standard adoption theories usually relate to an entirely different context, namely work situation in an organization. Gary Johns (Johns, 2006, 2001) suggests that context in an adoption research is not "sufficiently recognized or appreciated by researchers" and we contend that these contextual problems in an organizational setting will be further exacerbated in non-organizational environments like assistive technologies for seniors and in particular assistive robots, the subject of this paper. The empirical framework that emerges from the Capability Approach is likely to be useful to information system researchers seeking to undertake comparative analysis on adoption of similar technologies among seniors.

The work examines the factors that influence the opinions of the elderly about the transfer effect of assistive robots. From a practice perspective, the framework provides an empirical reference to aged care and nursing professionals for the issues influencing the adoption of such an intervention among elderly.

Limitations

Need for Further Qualitative Research: While most of studies in the adoption of assistive technologies among seniors have followed the tradition of quantitative approaches, the complexity of the problem and the dynamics of context have hindered insights into the depth of the problem and the generation of hypotheses to test further (Vichitvanichphong et al., 2013a). In that vein, the main focus of this study is to uncover the seniors' perceptions as extracted from contextual interviews, which calls for having a theory in place, viz. the Capability Approach, by which to understand the underlying opinions of the seniors. However, the authors acknowledge the need for further qualitative research and planning to examine the hypotheses presented in this paper and to generate new hypotheses.

Need for Observational Studies: Unfortunately, our ethical approval strictly asked us to not record our observations during the workshops. This was due to the fact that the workshops were advertised and conducted by an initiative in which the purpose of these sessions indicated as improving the elderly's awareness and not conducting any study. Therefore, we were asked to contact the elderly after the workshop for any further research. However, this indicates the need for an observational study which can aim to address how familiarization with the technology influenced the seniors' ability to comment on and imagine the use of the robots.

Limited Number of Participants: Authors acknowledge the limited number of participants, particularly when analyzing the x^2 metric. Authors are planning to re-run the course for more number of participants which would add to reliability of the results.

Limited Findings on socio-economic issues: The present study could not provide a sufficient level of depth in socio-economic issues such as cost, technical support, and so on. The findings are also limited

in terms of emotional aspects of adoption. This motivates researchers in this area to incorporate some targeted questions to these aspects in the interviews for larger scale data collections.

References

Ajzen, I., 1991. The theory of planned behavior. Organ. Behav. Hum. Decis. Process. 50, 179–211. doi:10.1016/0749-5978(91)90020-T

Alceste software [WWW Document], 1986. URL http://www.image-zafar.com/en/alceste-software (accessed 2.16.15).

Amrollahi, A., Ghapanchi, A.H., Talaei-Khoei, A., 2013. A systematic literature review on strategic information systems planning: Insights from the past decade. Pac. Asia J. Assoc. Inf. Syst. 5, 4.

Bedaf, S., Gelderblom, G.J., Syrdal, D.S., Lehmann, H., Michel, H., Hewson, D., Amirabdollahian, F., Dautenhahn, K., de Witte, L., 2013. Which activities threaten independent living of elderly when becoming problematic: inspiration for meaningful service robot functionality. Disabil. Rehabil. Assist. Technol. 1–8.

Bedny, G., Meister, D., 1997. The Russian Theory of Activity: Current Applications To Design and Learning, Series in Applied Psychology. Psychology Press.

Bemelmans, R., Gelderblom, G.J., Jonker, P., De Witte, L., 2012. Socially assistive robots in elderly care: A systematic review into effects and effectiveness. J. Am. Med. Dir. Assoc. 13, 114–120. e1.

Braun, M.T., 2013. Obstacles to social networking website use among older adults. Comput. Hum. Behav. 29, 673–680. doi:10.1016/j.chb.2012.12.004

Broadbent, E., Stafford, R., MacDonald, B., 2009. Acceptance of healthcare robots for the older population: Review and future directions. Int. J. Soc. Robot. 1, 319–330.

Broekens, J., Heerink, M., Rosendal, H., 2009. Assistive social robots in elderly care: a review. Gerontechnology 8, 94–103.

Cofer, C.N., Appley, M.H., 1964. Motivation: Theory and research.

Conci, M., Pianesi, F., Zancanaro, M., 2009. Useful, Social and Enjoyable: Mobile Phone Adoption by Older People, in: Gross, T., Gulliksen, J., Kotzé, P., Oestreicher, L., Palanque, P., Prates, R.O., Winckler, M. (Eds.), Human-Computer Interaction – INTERACT 2009, Lecture Notes in Computer Science. Springer Berlin Heidelberg, pp. 63–76.

Cornish, F., 2006. Empowerment to participate: a case study of participation by indian sex workers in HIV prevention. J. Community Appl. Soc. Psychol. 16, 301–315. doi:10.1002/casp.866

Cumming, E., Henry, W., 1961. Growing old: the process of disengagement. Basic Books, New York.

Czaja, S.J., Charness, N., Fisk, A.D., Hertzog, C., Nair, S.N., Rogers, W.A., Sharit, J., 2006. Factors predicting the use of technology: findings from the Center for Research and Education on Aging and Technology Enhancement (CREATE). Psychol. Aging 21, 333–352. doi:10.1037/0882-7974.21.2.333

Czaja, S.J., Lee, C.C., 2007. The impact of aging on access to technology. Univers. Access Inf. Soc. 5, 341–349. doi:10.1007/s10209-006-0060-x

Davis, F.D., 1989. Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS Q. 13, 319–340.

Davis, F.D., Bagozzi, R.P., Warshaw, P.R., 1989. User acceptance of computer technology: a comparison of two theoretical models. Manag. Sci. 35, 982–1002.

Elmes, D.G., Kantowitz, B.H., Roediger III, H.L., 1992. Research methods in psychology. Cengage Learning.

Feil-Seifer, D., Mataric, M.J., 2005. Defining socially assistive robotics, in: Rehabilitation Robotics, 2005. ICORR 2005. 9th International Conference on. IEEE, pp. 465–468.

Fishbein, M., Ajzen, I., 1980. Predicting and understanding consumer behavior: Attitude-behavior correspondence. Understanding attitudes and predicting social behavior 148–172.

Gamberini, L., Raya, M.A., Barresi, G., Fabregat, M., Ibanez, F., Prontu, L., 2006. Cognition, technology and games for the elderly: An introduction to ELDERGAMES Project. PsychNology J. 4, 285–308.

Gill, T.M., Baker, D.I., Gottschalk, M., Peduzzi, P.N., Allore, H., Byers, A., 2002. A program to prevent functional decline in physically frail, elderly persons who live at home. N. Engl. J. Med. 347, 1068–1074.

Heerink, M., Ben, K., Evers, V., Wielinga, B., 2008. The Influence of Social Presence on Acceptance of a Companion Robot by Older People. J. Phys. Agents 2, 33–40.

Heerink, M., Kröse, B., Evers, V., Wielinga, B., 2010. Assessing Acceptance of Assistive Social Agent Technology by Older Adults: the Almere Model. Int. J. Soc. Robot. 2, 361–375. doi:10.1007/s12369-010-0068-5

Huebner, E.S., Valois, R.F., Suldo, S.M., Smith, L.C., McKnight, C.G., Seligson, J.L., Zullig, K.J., 2004. Perceived quality of life: A neglected component of adolescent health assessment and intervention. J. Adolesc. Health 34, 270–278.

Illeris, K., 2004. The three dimensions of learning. Malabar, Fla: Krieger Pub. Co.

Jaspars, J.M.F., Fincham, F.D., Hewstone, M., 1983. Attribution Theory and Research: Conceptual, Developmental, and Social Dimensions. Academic Press.

Johns, G., 2006. The Essential Impact of Context on Organizational Behavior. Acad. Manage. Rev. 31, 386–408. doi:10.5465/AMR.2006.20208687

Johns, G., 2001. In praise of context. J. Organ. Behav. 22, 31–42. doi:10.1002/job.80

Keele, S., 2007. Guidelines for performing systematic literature reviews in software engineering. Technical report, EBSE Technical Report EBSE-2007-01.

Kiel, J.M., 2005. The digital divide: Internet and e-mail use by the elderly. Med. Inform. Internet Med. 30, 19–23. doi:10.1080/14639230500066900

Klamer, T., Ben Allouch, S., 2010. Acceptance and use of a social robot by elderly users in a domestic environment, in: Pervasive Computing Technologies for Healthcare (PervasiveHealth), 2010 4th International Conference on-NO PERMISSIONS. Presented at the Pervasive Computing Technologies for Healthcare (PervasiveHealth), 2010 4th International Conference on-NO PERMISSIONS, pp. 1–8. doi:10.4108/ICST.PERVASIVEHEALTH2010.8892

Lam, J.C.Y., Lee, M.K.O., 2006. Digital Inclusiveness--Longitudinal Study of Internet Adoption by Older Adults. J. Manag. Inf. Syst. 22, 177–206. doi:10.2753/MIS0742-1222220407

Laver, K., Ratcliffe, J., George, S., Burgess, L., Crotty, M., 2011. Is the Nintendo Wii Fit really acceptable to older people?: a discrete choice experiment. BMC Geriatr. 11, 1–6. doi:10.1186/1471-2318-11-64

Li, J., Talaei-Khoei, A., Seale, H., Ray, P., MacIntyre, C.R., 2013. Health care provider adoption of ehealth: systematic literature review. Interact. J. Med. Res. 2.

Merten, M., Howar, F., Steffen, B., Margaria, T., 2012. Automata Learning with On-the-Fly Direct Hypothesis Construction. Springer.

Michaud, F., Boissy, P., Labonte, D., Corriveau, H., Grant, A., Lauria, M., Cloutier, R., Roux, M.-A., Iannuzzi, D., Royer, M.-P., 2007. Telepresence Robot for Home Care Assistance., in: AAAI Spring Symposium: Multidisciplinary Collaboration for Socially Assistive Robotics. California, USA, pp. 50–55.

Najaftorkaman, M., Ghapanchi, A.H., Talaei-Khoei, A., Ray, P., 2015. A taxonomy of antecedents to user adoption of health information systems: A synthesis of thirty years of research. J. Assoc. Inf. Sci. Technol. 66, 576–598.

OECD, 2012. World Population Ageing: 1959-2050. Paris.

Orimo, H., Ito, H., Suzuki, T., Araki, A., Hosoi, T., Sawabe, M., 2006. Reviewing the definition of "elderly". Geriatr. Gerontol. Int. 6, 149–158. doi:10.1111/j.1447-0594.2006.00341.x

Ormrod, J., 2012. Human learning (6th ed.). Pearson, Boston.

Pombo-de-Barros, C.F., 2011. Análise textual com o Programa ALCEST: uma aplicação em pesquisa de representações sociais no campo da política. MATTOS RA BAPTISTA TWF Caminhos Para Análise Políticas Saúde 275–278.

Reinert, M., 1998. Quel objet pour une analyse statistique du discours? Quelques réflexions à propos de la réponse Alceste, in: JADT. pp. 557–569.

Plutchik, R. (1984). Emotions: A general psychoevolutionary theory. Approaches to emotion, 1984, 197-219.

Robeyns, I., 2005a. The capability approach: a theoretical survey. J. Hum. Dev. 6, 93–117.

Robeyns, I., 2005b. The Capability Approach: a theoretical survey. J. Hum. Dev. 6, 93–117. doi:10.1080/146498805200034266

Rogers, E.M., 1962. Diffusion of innovations (1st ed.). N. Y. Free Press.

Sen, A., 1999. Commodities and Capabilities (OUP Catalogue). Oxford University Press.

Sen, A.K., 1990. Development as capability expansion.

Sharp, J.H., 2006. Development, extension, and application: a review of the technology acceptance model. Director 07.

Shin, D., 2010. Ubiquitous Computing Acceptance Model: end user concern about security, privacy and risk. Int. J. Mob. Commun. 8, 169–186. doi:10.1504/IJMC.2010.031446

Steele, R., Lo, A., Secombe, C., Wong, Y.K., 2009. Elderly persons' perception and acceptance of using wireless sensor networks to assist healthcare. Int. J. Med. Inf. 78, 788–801. doi:10.1016/j.ijmedinf.2009.08.001

Tapus, A., Maja, M., Scassellatti, B., 2007. The grand challenges in socially assistive robotics. IEEE Robot. Autom. Mag. 14, N/A.

Theng, Y.-L., Chua, P.H., Pham, T.P., 2012. Wii as entertainment and socialisation aids for mental and social health of the elderly, in: CHI'12 Extended Abstracts on Human Factors in Computing Systems. ACM, pp. 691–702.

Venkatesh, V., Morris, M.G., Davis, G.B., Davis, F.D., 2003. User Acceptance of Information Technology: Toward a Unified View. MIS Q. 27, 425–478. doi:10.2307/30036540

Vichitvanichphong, S., Kerr, D., Talaei-Khoei, A., Ghapanchi, A.H., 2013a. Analysis of Research in Adoption of Assistive Technologies for Aged Care. Presented at the 24th Australasian Conference on Information Systems, RMIT University.

Vichitvanichphong, S., Talaei-Khoei, A., Kerr, D., Ghapanchi, A.H., 2014. Assistive Technologies for Aged Care: Supportive or Empowering? Australas. J. Inf. Syst. 18. doi:10.3127/ajis.v18i3.880

Vichitvanichphong, S., Talaei-Khoei, A., Kerr, D., Ghapanchi, A.H., 2013b. Adoption of Assistive Technologies for Aged Care: A Realist Review of Recent Studies. Presented at the The Hawaii International Conference on System Sciences.

Wilkowska, W., Ziefle, M., 2009. Which Factors Form Older Adults' Acceptance of Mobile Information and Communication Technologies?, in: Holzinger, A., Miesenberger, K. (Eds.), HCI and Usability for E-Inclusion, Lecture Notes in Computer Science. Springer Berlin Heidelberg, pp. 81–101.

Wu, Y., Wrobel, J., Cornuet, M., Kerhervé, H., Damnée, S., Rigaud, A.-S., 2014. Acceptance of an assistive robot in older adults: a mixed-method study of human–robot interaction over a 1-month period in the living lab setting. Clin. Interv. Aging 9, 801.