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Changes in the technological landscape over time : everyday technologies relevance and difficulty levels as perceived by older adults with and without cognitive impairment.

Malinowsky, Camilla; Kottorp, Anders; Patomella, Ann-Helen; Rosenberg, Lena; Nygård, Louise

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Abstract

BACKGROUND:

Everyday technology, ET (e.g. computers, TV´s and vending machines) perceived as relevant and used in everyday activities change continuously. Not being able to keep up with these changes may hinder participation in activities.

OBJECTIVE:

To investigate stability and change in perceived relevance of ET, and in levels of perceived ET difficulty across two different occasions in time and between two similar samples of older adults with and without cognitive impairment.

METHODS:

Data of perceived relevance and difficulty in ET use in the samples (n=157/118), collected with the Everyday Technology Use Questionnaire (ETUQ) was investigated.

RESULTS:

Thirty-three (70%) of the ETs in the ETUQ significantly increased in relevance, while the perceived levels of difficulty were statistically similar in 40/47 ETs (85%) across the two time occasions.

CONCLUSIONS:

The perceived relevance of ET among older adults with and without cognitive impairment was indicated to increase over time, but the levels of perceived levels of difficulty of ETs did not change as much. This knowledge could be used to support and facilitate ET use in the aging population, and in general to influence society's view of older people as active users of ET in activities at home and in public spaces.

Keywords: Dementia, mild cognitive impairment, ADL, IADL, technology

Introduction

The use of technology such as computers, ticket vending machines, and Internet banking is increasing in all age groups [1]. Everyday technologies (ET) that we use in activities are part of the technological landscape, in other words, the technological artifacts and services that we meet and use in everyday life [2]. However, the technological landscape is constantly changing, which implies that the way activities are performed may also change. ETs such as the rotary dial phone and the video have more or less fallen out of use and are no longer as relevant as they used to be, while new ones such as smart phones and DVD players have become part of our technological landscape. This means that individuals may replace the ETs they use when engaging in different activities as a result of changes in the technological landscape. Not being able to keep up with changes in the technological landscape could hinder individuals' participation in activities at home and in public spaces [3], particularly if they are older adults with cognitive impairment. As an example, Slegers and colleagues [4] found that for some technological artifacts and services used in everyday life might be difficult to find non-technological alternatives; these include cash machines and automatic telephone services.

In the present study, the technology used in everyday life activities is conceptualized as ET, which includes all the technological artifacts and services that are used in activities in homes and in society [5]. ETs that the person owns or has access to in this study are conceptualized as relevant to the person given that they are in use, have been used or if the person has an intention or wish to start using them. Perceived difficulty level of an ET is conceptualized as how easy or difficult the person's experiences of his/her use of the ET may be. The use of technology among older adults with and without cognitive impairment has been investigated in previous studies by placing the focus on different aspects of use, for example, use/non-use of technology, acceptance of technology, relevance of technology, and perceived and observed difficulty of managing technology [6-9]. However, these studies have not investigated changes in perceived relevance of ET used in everyday activities. How the perceived relevance of different ETs change over time among older adults with cognitive impairments is an important aspect that is likely to influence acceptance of technology, as perceptions of ETs' relevance can be seen as an umbrella covering many of the known acceptance factors: e.g., concerns and benefits expected from technology, need for technology, and social influence [10].

According to the Model of Human Occupation (MoHO) [11], the properties and meanings of objects – including ETs – influence how people use them. Moreover, the perceptions that people have of objects, including technology, and of their ability to use them are formed by their experiences, values, and needs but also by contextual norms. These perceptions also influence acceptance of technology [11]. For example, changes in social and societal norms regarding what ETs should be used will influence peoples' perceptions of ETs' relevance and hence also their choices of whether to bring new ETs into their lives or not. Also, the activities where the ETs are used will influence how relevant and difficult ETs will be perceived. Older adults with cognitive impairment due to dementia or mild cognitive impairment (MCI) have been found to perceive less ET as being relevant to use than those with no known cognitive impairment [8, 9]. Yet studies have shown that several technological artifacts and services are used by older adults although they are perceived as challenging to use, specifically for those with cognitive impairment [8, 9]. However, we know little of how older adults with and without cognitive impairment follow the increasingly faster changes in trends of ET possession and use. For example, what ETs do they perceive as relevant and how does perceived relevance change as time passes? Which ETs are perceived as difficult/easy to use by them, and do these perceptions change over time? In order to support the use of ET that is relevant, wanted, and needed in the everyday lives of older adults with and without cognitive impairment, health care professionals, technology designers and community planners need answers to questions such as these. We propose that increased knowledge of the perceived relevance of ET and the perception of ET's level of difficulty when used in everyday life activities by older adults will help to develop timely changes and interventions. Such knowledge will also facilitate the development and adaptation of ET and ET-based services that will decrease the challenge and enhance the individual's ability to manage ET that he/she wants and/or needs to use [12].

Consequently, in order to be able to facilitate their opportunities to benefit from ET, it is vital to gain more knowledge of how perceived relevance and level of perceived difficulty of ET may change over time in the population of older adults with and without cognitive impairment. The Everyday Technology Use Questionnaire (ETUQ) has been used in earlier studies at different points in time to investigate and compare the perceived relevance of ET and difficulty in ET use among older adults with and without cognitive impairment [8, 9]. These studies also generated hierarchies that describe the level of perceived ET difficulty for a number of ETs, as well as data on the perceived relevance for these ETs. These data might capture changes of perceived ET relevance over time as well as of perceived ET difficulty for the users; these perceptions are proposed to illustrate stability and change in the technological landscape for the present population. The aim of this study is hence to investigate stability and change in perceived relevance of ETs across two different occasions in time. In addition, the study aims at investigating the stability in the hierarchies of levels of perceived ET difficulty across two different occasions in time and between two similar samples of older adults with and without cognitive impairment.

Methods

Study design

This study investigates the perceived relevance and perceived level of difficulty of 47 ETs across two different periods of time (2003-2005 and 2008-2009), and between two similar samples of older adults with and without known cognitive impairment. The study is based on secondary analyses of data from two earlier studies where the perceived relevance and difficulty in use of their own, common ET products and services in the samples were investigated by the same research group using the ETUQ. From each of those two studies, a list of ETs sorted according to how relevant they were perceived to be, and a hierarchy of the perceived levels of ET difficulty was generated [8, 13]. The two studies and the lists of ETs' relevance and hierarchies of the perceived levels of ET difficulty and the list of ETs relevance are hereafter referred to as ETUQ1 [13] and ETUQ2 [8].

Sample

In each of the two studies on which the secondary analyses are based, two samples of older adults, both comprising three sub-samples, persons with dementia, mild cognitive impairment (MCI), and persons without known cognitive impairment (ETUQ1 n=157; ETUQ2 n=118) were interviewed by use of the ETUQ (see Table 1). Data from the two samples (ETUQ1 and ETUQ2) were initially analyzed separately. For inclusion in the original studies the participants had to: a) be 55 years or older, b) use some ETs in daily life and, c) be motivated to participate in the study. Persons with other diagnoses that could cause cognitive deficits, such as stroke, were excluded. In addition, persons with visual and/or hearing impairments that could not be compensated with technical aid(s) were excluded. As the two samples (ETUQ1 and ETUQ2) consisted of different individuals, they were initially compared for differences regarding the following variables: age, sex, and Mini Mental State Examination

(MMSE)-score [14]. The samples showed some differences among two of these variables, age and MMSE score (see Table 1), while the gender distribution was similar. Even though some studies have shown that age seems to influence non-use/use of ET and acceptance of ET [6], other studies have indicated that age (within a group of older adults) does not seem to have a significant influence on the perceived difficulty in the use of ET [8, 13]. Given that the present study concerns level of relevance and difficulty of ETs based on perceptions rather than non-use/use and acceptance, we therefore decided to proceed with the analysis even though the mean age differed by 3.7 years between the samples (ETUQ1: 73.6 years, ETUQ2: 69.9 years). Also, even though there was a statistically significant difference in the MMSE scores between the samples, the actual difference in the scores was only 1.3. Thus, we did not consider this difference to be clinically significant and the effect size of the difference was also small (d=0.29) [15]. The ETUQ1 sample had a larger share (59%) of older adults without known cognitive impairment compared to the ETUQ2 sample (37%).

Insert Table 1 about here

In both studies, potential participants with dementia or MCI were recruited through memory investigation units in Sweden, in collaboration with personnel at the units. These participants had been diagnosed by a physician based on the Diagnostic and Statistical Manual of Mental Disorders, DSM-IV, [16] and the National Institute of Neurological and Communicative Disorders and Stroke and the Alzheimer's Disease and Related Disorders Association, NINCDS-ADRDA, [17] criteria for dementia and the criteria described by Petersen [18] and Winblad et al. [19] for MCI. The older adults without known cognitive impairment were recruited through voluntary retirement organizations and networks as well as through invitations from the data collectors to people they knew fulfilled the criteria for inclusion.

Instrument

The ETUQ was developed to identify the perceived relevance of ETs as chosen from a list, as well as the perceived difficulty to use these ETs. The ETUQ comprises a large number of items (ETUQ1, n=86, ETUQ2, n=92), i.e., technological artifacts and services, and these are administered in a 30-to-45-minute face-to-face interview. The items are sorted into eight activity areas, including household activities, accessibility, and transportation, and examples of items are microwave oven, code-operated door lock, and automated check-in at airport [13]. The ETs in the ETUQ are chosen to capture the present variation of technology that exists in the technological landscape, and this implies that the selection of ETs in the ETUQ needs to and can be revised continuously (i.e., inclusion of new ETs and exclusion of those that are no longer in use). The ETUQ interviews produce information about which ETs are perceived as relevant or irrelevant in everyday life activities. According to the ETUQ manual [20, 21], an ET is regarded as relevant if the person has access to it and a) uses it, b) has been using it or c) intends to start using it. The perceived difficulty in the use of those ETs that are relevant to the person is then registered. Difficulties are graded using a six-grade scale comprising a range from small difficulties such as hesitations or just needing extra time, to major difficulties when the person may need the help or the presence of another person in using the ET, and eventually to stop using the ET. The ETUQ has demonstrated sound psychometric properties; more specifically, it has been shown to uphold acceptable internal scale validity, unidimensionality, and person response validity in a study of older adults with and without cognitive impairment [13].

Data-gathering procedures

Data was mostly collected by experienced, specially trained occupational therapists. The data from older adults without known cognitive impairment in ETUQ1 was collected by occupational therapy undergraduate or master degree students. All data collectors were trained by the principal investigator (xx) in administering and scoring the standardized ETUQ. In addition, in order to make the evaluations with the ETUQ as valid and reliable as possible, a detailed manual was used by the data collectors [20, 21]. The ETUQ interviews generally took place in the participant's home. In order to gain the best data quality, participants with dementia were allowed to have a significant other present as support for the interview [13]. The procedures for inclusion of participants and data-gathering are presented in more detail elsewhere [8, 13]. Before the initiation of the studies, approvals from the Regional Ethical Committee were obtained. Written consent was obtained from each participant.

Analysis of data

The collected data from the ETUQ interviews had first been analyzed in each of the original studies using a Rasch rating scale model [22] with the Winsteps application [23]. In the Winsteps analyses, the raw scores from the ETUQ interviews (ETUQ1 and ETUQ2, separately) were converted into abstract intervals through logistic transformation of the pattern of responses on items (as well as participants), and the linear relationship between the different ETs could be illustrated. The Winsteps analyses generated item calibration measures of the perceived relative difficulty, expressed in logits (**log**arithm of the odds probability un**its**), for each ET. These item calibration measures, or logits, are generated based upon the pattern of responses across all clients in the sample, and the higher measure (in logits), the more perceived difficulty using the ET. The relative estimate of each item calibration should be similar regardless of any sub-samples within the larger sample, as long as the pattern demonstrates acceptable stability. Thus, although there were some differences in proportions in the diagnostic sub-samples between the two samples, this should have no or minimal impact on the relative placement of the items within each sample [22]. The validity of the item estimates are reflected in the individual item goodness-of-fit statistics generated from the Rasch analysis. These indicate the correspondence between the actual responses on the ETUQ and the responses expected by the Rasch measurement model. The goodness-of-fit statistics are presented in infit and outfit Mean-Square (MnSq) and are associated with a z-value. The infit statistics are weighted and sensitive to performances of persons with ability close to the ET difficulty, while the outfit statistics are not weighted and are more sensitive to unexpected responses from outlying sources [22]. The ETs were, according to the item calibration measures, ordered in two hierarchies ranging from more to less difficult ETs: i.e., one hierarchy of ET difficulty for each sample, respectively (ETUQ1 and ETUQ2).

To be able to compare stability in the two ET hierarchies of measures of perceived level of ET difficulty (ETUQ1 and ETUQ2), ETs that were absent or conceptualized differently in any of the two were excluded. Next, ETs that did not fit into the criteria for acceptable goodness-of-fit to the Rasch model were excluded. The reasons for exclusion were that the ETs:

(1) were defined as different items, e.g., in ETUQ1 there was one item called "DVD/video," and in ETUQ2 these ETs were divided into two items "DVD" and "Video," separately (18 ETs were removed due to this reason);

(2) were only included in ETUQ1 such as rotary dial telephone, fuse, fax machine, swinging doors and sliding automatic doors, (12 ETs); or

(3) were added in ETUQ2 in order to ensure current and recent technology development such as video camera, MP3-player, lawnmower and grinding machine (19 ETs); and

(4) did not meet the criteria for acceptable goodness-of-fit to the Rasch model, i.e., infit and outfit MnSq values of 0.6-1.4 [24] in association with a z less than 2 [22] (8 ETs: sewing machine, iron, shaver, electric toothbrush, coin lock public toilet, thermometer, hair dryer, vacuum cleaner).

The reduction of ETs that did not match in the two samples resulted in two hierarchies of 47 similar ETs. All of these 47 ETs had been rated by eight participants or more. This would minimize the risk for generating ET difficulty calibration measures based on a limited number of responses, which could impact on the generalizations of comparisons in further analyses.

The comparisons of ET relevance and difficulty over time were done in three steps:

(1) To investigate the **change in perceived relevance of ETs** in the ETUQ across the two different occasions in time, the number of participants who currently perceived each ET as relevant was counted and then the proportion in percentage of relevance in relation to all the 157/118 participants was calculated per item. The proportions were compared for each ET between the ETUQ1 and ETUQ2 statistically, using Chi-square distributions with a level of significance set at $p<0.05$. Also, the mean perceived relevance on a group-level of the original 86/92 ETs in the ETUQ1 and ETUQ2 was compared between the three sub-samples using t-tests with a level of significance set at $p<0.05$.

2) In order to evaluate **change in perceived levels of ET item difficulty** over time, we investigated if the item calibration measures remained statistically stable over time by using the Differential Item Functioning (DIF) analysis. Because the sizes of the Standard Errors (SE) for ETs in ETUQ2 were small due to a relatively high amount of responses for most ETs, the SEs in ETUQ2 were adjusted to 0.15 in the DIF analysis, in conjunction with other studies [25, 26]. This was done to minimize the risk of generating significant item DIF due to

artificially small SEs, as item SE is sample dependent. A z-value ≥ +/- 3, corresponding to a 99% confidence interval, was used as a criterion in order to avoid type II errors when detecting ETs that had increased/decreased in difficulty over time.

(3) Finally, to further examine the relationship of the perceived level of ET difficulty in the ETUQ across the two different occasions has changed over time (indicating **changes across ET difficulty** hierarchies), the ET items' calibration measures (in logits) from the two hierarchies were compared calculating the Pearson product-moment correlation in the SPSS (Statistical Package for Social Sciences) [27]. To decide the strength of the association between the hierarchies, guidelines from social sciences were applied: 0.1-0.3=small, 0.3-0.5=medium, and 0.5-1.0=large [28].

Results

Change in perceived relevance of ETs across two different occasions in time

All of the 47 ETs were perceived as similar or as more relevant in the ETUQ2 compared to the ETUQ1 (see Figure 1). Thirty-three of the ETs (70%) demonstrated a statistically significant change in relevance across the two time occasions (see Table 2). In Table 2, the hierarchies and measures of perceived difficulty of each ET from the ETUQ1 and ETUQ2 are presented. In Figure 2, the increase in relevance for the 15 ETs with the largest increase in relevance across the different occasions in time is presented. It shows that almost all of these 15 ETs are information and communication technologies (ICTs) such as cell phones and computers.

Comparing the data of perceived relevance from the original analyses of the 86 ETs in the ETUQ1 and the 92 ETs in the ETUQ2, we found that the mean perceived relevance of ET differs between the three groups in the samples. The mean proportion of perceived relevance of ET increased to a higher degree over time in the groups of person with dementia (from 46.71%, SD 11.59 to 51.49%, SD 9.19, t-test p=0.06) and MCI (from 49.60%, SD 12.5 to 63.86%, SD 10.7, t-test p<0.001) than in the group of older adults without known cognitive impairment (from 67.95%, SD 10.58 to 69.5%, SD 10.66, t-test p=0.44).

Insert Figures 1 and 2 about here

Relationship between the perceived levels of ET difficulty in the ETUQ across the two different occasions in time

In the DIF analysis it was shown that seven of the 47 ETs (15%) statistically differed in perceived level of difficulty between the two occasions (see Table 2). Among these seven ETs with a change in level of difficulty, six (Internet communication, Internet banking, Internet information, curling iron, Cell phone: other services, Cell phone: text message) were perceived as relatively easier to use as compared to the other ETs by the more recent sample; i.e., the ETUQ2. Only one ET (elevator) was perceived as relatively more difficult to use as compared to the other ETs by the more recent sample than by the earlier one. The perceived levels of difficulty were statistically similar in the ETUQ1 and ETUQ2 for 40 of the 47 ETs (85%). In Table 2, the perceived levels of difficulty for all the 47 ETs in the ETUQ1 and ETUQ2 are presented.

Insert Table 2 about here

Stability of the item calibration hierarchies of perceived level of ET difficulty in ETUQ across two different occasions in time

The correlation between the ETUQ1 and ETUQ2 hierarchies of perceived level of ET difficulty demonstrated a Pearson correlation coefficient of 0.7 associated with a *p*-value of <0.001. This indicates a strong positive relationship between the ETUQ1 and ETUQ2, that is, the two hierarchies of perceived level of ET difficulty are to a large extent associated over time.

Discussion

The findings showed that 70% (33/47) of the ETs evaluated with the ETUQ demonstrated a statistically significant increase in perceived relevance for the two samples of older adults across the two time occasions. With regard to earlier findings of significantly lower perceived relevance of ETs among older adults with MCI or dementia than among those without known cognitive impairment [8, 9] and the fact that the proportion of participants with AD and MCI was higher in the ETUQ2 (63%) than in the ETUQ1 (41%), an overall decrease in perceived ET relevance would instead have been expected. This deserves some reflections. To incorporate new technology into everyday activities, people need to adapt to the technological landscape. Yet, as persons with MCI and dementia have reduced cognitive functions, and consequently face limitations when it comes to developing new habits and skills, incorporation of new technology could be presumed challenging. Nevertheless, in our comparisons of the original ETUQ data of the 86/92 ETs in the ETUQ1 and ETUQ2, it was demonstrated that the perceived relevance of ET increased more for persons with dementia than for those without cognitive impairment. In particular, the difference in perceived relevance of ET between persons with MCI and those with no known cognitive impairment decreased over time in the samples. These new findings challenge the assumption that ETs are more relevant to use by older adults without cognitive impairment than for those with cognitive impairment [8, 9]. Future studies can explore these topics in more depth.

An increased perceived relevance of ET during a period of 3-5 years could reflect the fast expansion of the technological landscape, i.e., a change in technologies that are used in everyday life in society at large [4]. The increase in perceived relevance over time of ETs could also be due to an overall increased use of technological artifacts and services in everyday activities among older adults with and without cognitive impairment. That is, more everyday activities relevant for these persons could be presumed to include the use of ET as time passes. However, as earlier studies have shown that persons with MCI and dementia have more difficulties in the use of ET than those without cognitive impairment [7-9], it would seem reasonable to assume that an increased general use and incorporation of ET in everyday activities could make these more difficult to perform for people with cognitive impairment, and there is a risk that participation in activities at home as well as in society will be affected. However, our findings did not just show that ETs were perceived as more relevant over time in our samples, but also that several of these ETs were perceived as relatively easier to use. This suggests that the more common and habitual ETs become in everyday activities, the less difficult they will be perceived [29]. If technologies are perceived as easy to use, this will also likely influence older adults' acceptance of them as easy technologies that would be expected to cause fewer concerns [10]. One promising avenue is to further build on smart phones and tablets as platforms for a variety of functions, also including supportive technology. This seems promising since these technologies are increasingly used also by older adults, and they are commonly used in society, thereby signaling “normality” which is important for acceptance [30].

Although the findings demonstrated a strong positive relationship between data from the ETUQ1 and ETUQ2, and thereby indicated a stable hierarchy of level of perceived ET difficulty in ETUQ, there were seven ETs that differed in level of perceived difficulty between the two occasions. Most ETs were more recently developed technological artifacts and services such as ICTs, i.e., cell phones, answering machines, and Internet. Modern technologies are sometimes described as having a more complex, often multi-layered design requiring the user to handle several functions and services, which might make them difficult to use [29, 31, 32]. On the other hand, new technologies might be designed to be more user-friendly as our knowledge about such aspects increase [33]. However, the findings indicate that older adults with and without cognitive impairment have possibilities to learn to use new ETs and adjust to changes in the technological landscape. Nonetheless, clinicians and designers may need to pay attention to the ETs that are placed in the upper end of the hierarchy, as these ETs were found to be most difficult to manage for all older people (with and without cognitive impairment).

However challenging incorporation of new technology might be, studies have described that a perceived need and significance of an ET in combination with frequent use might make learning to manage a new or unfamiliar ET possible for a person with AD [34, 35]. It may also be important that the person continues using an ET in order to retain the ability to use it [35]. Moreover, as many of the ETs that were perceived as easier to use were among those that had increased most in perceived relevance over time in the samples, the increase in relevance might be one reason for the decrease in perceived level of difficulty for the ETs. The decrease might also be influenced by a change in older adults' motivation to use the ETs. We know that if an ET is seen by the user to facilitate and support everyday life, he or she might be more motivated to use it. This might in turn affect the user's acceptance of it and also influence the level of perceived difficulty of the ET [10, 36-38]. Issues such as these are proposed to be of increasing importance in health care and community planning. It would be interesting to further investigate the relationship between the perception of ETs' relevance and the level of ETs' difficulty over time, in order to increase the knowledge of changes in older adults' ET use.

While technological artefacts or systems intended to support everyday activities and participation are continuously being developed, they have to be accepted and incorporated in each user's everyday life in order to be of value. This is critical and presents a challenging task for health care professionals. A better understanding of how relevant and difficult people perceive ETs to be and how such perceptions may change over time would therefore be of great value. To be able to capture changes in the technological landscape and thereby provide current reflections of older adults as technology users, it is important that instruments for evaluation of ETs' relevance and difficulty are flexible and can be continuously adjusted to ongoing changes. The ETUQ seems to have a potential to capture these changes, as it can be adjusted for developments and variations in ET use by including new ETs and discarding ETs no longer in use, as long as they fit the Rasch measurement model [22]. For the ETs that demonstrate a more unexpected response pattern than is accepted in the Rasch measurement model, further research is needed to identify any systematic pattern that could explain this. One relevant question to ask is: Are certain ETs relatively more easy to use for certain subgroups (gender, culture, diagnosis)? Such studies will further reveal important information for more targeted actions.

It could be argued that instead of comparing the perceived relevance and difficulty levels of ETs between two samples at two different points in time, it would have been more interesting to follow the same persons over time. However, then the focus would have been on the individual changes in that sample over time and not on the influence of the technological landscape, which was our main interest in this study. A limitation in the present study was that the two samples differed significantly in age and in MMSE scores. However, as mentioned above, the aim was not to follow change in the persons' ability to use ET, but rather the relevance and perceived difficulty level of ETs over a period of time. Moreover, the inclusion and exclusion criteria, the sample-free statistics used, and the procedures of sampling the participants were similar in the two data collections. Only a limited number of items – i.e., ETs – changed their positions within the hierarchy of ETs' level of difficulty over time, and the relationship between the hierarchies from the ETUQ1 and ETUQ2 was strong. Thus, this suggests that the hierarchies are relatively stable over time and therefore may generate generic knowledge about ETs' difficulty levels as perceived by older adults.

To conclude, the present study shows how the perceived relevance of ETs used in everyday activities increased over time (2003/05 – 2008/09) in two samples of older adults with and without cognitive impairment. Most ET items did not, however, change their rank order of perceived difficulty over time. Among those items changing their placement over time, the majority of them became relatively easier to use. As perceived relevance is a prerequisite for use of technology, this indicates that an increased *use* of technological artifacts and services in everyday activities over time took place in our samples with and without cognitive impairment between the two points in time; however, the perceived ET difficulties did not change as much. This finding suggests that there are generic hierarchies of ETs' difficulty levels that are relatively stable over time. Such knowledge could be of interest to anyone who wants to support and facilitate ET use in everyday life for older people, and also for society's view of older people as active users of ET in society and at home.

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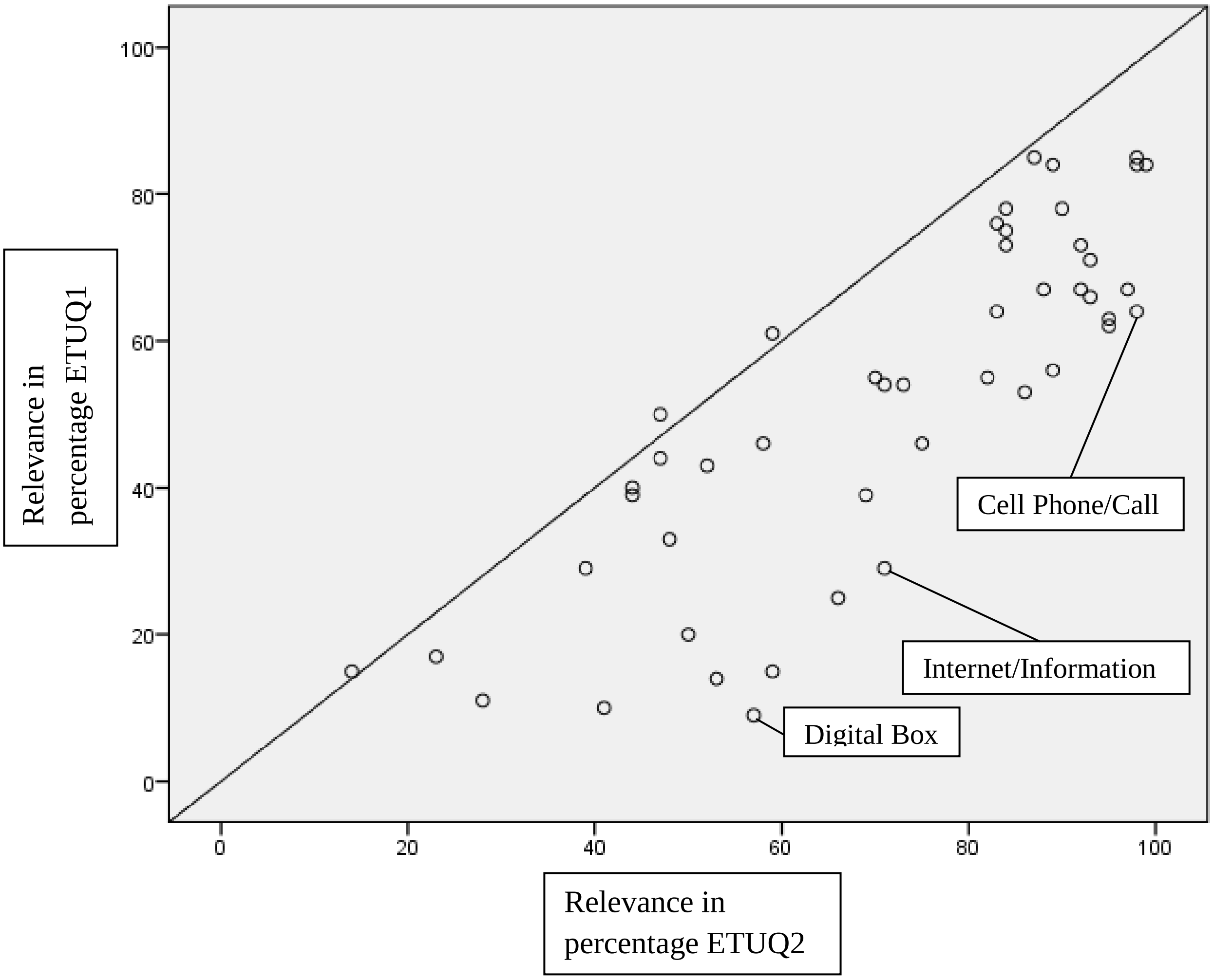

Figure 1. Perceived relevance of ETs (in percentage of ETs in the ETUQ) in ETUQ1 and ETUQ2 among older adults with and without cognitive impairment. Some examples are given regarding the ETs demonstrating largest change over time (see more detailed information in Figure 2).

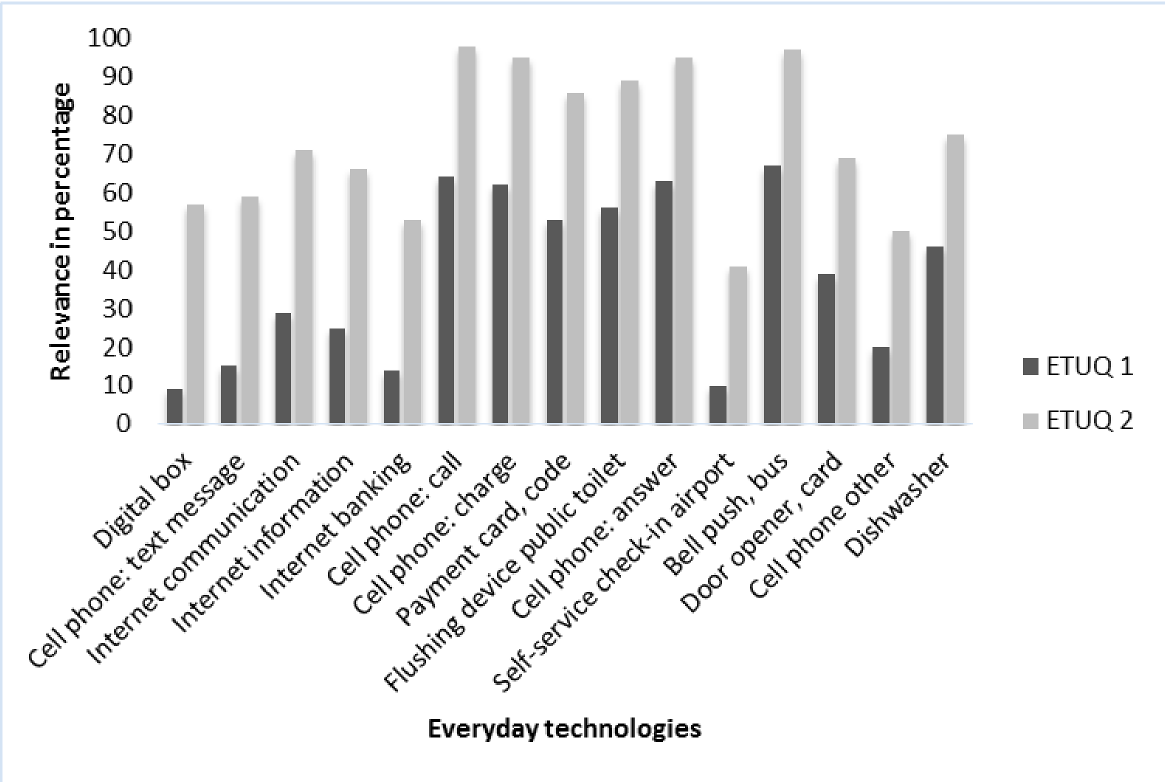

Figure 2. The 15 ETs with largest increase in relevance between the ETUQ1 and ETUQ2.

Table 1. Characteristics of the participants.

	ETUQ1 sample n=157	**ETUQ2 sample** n=118	**Comparison between the samples**
Groups, n			
Dementia	34	37	
Mild cognitive impairment	30	37	
Older adults with no known cognitive impairment	93	44	
Age, years (SD)	73.6 (7.49)	69.9 (8.91)	p<= 0.001 (t-test)
Gender, n (%)			NS (Pearson Chi^2)
Women	91 (58)	64 (54)	
Men	66 (42)	54 (46)	
MMSE, score (SD)	26.1 (5.85)	27.4 (2.53)	p<= 0.05 (t-test)

Table 2. Description of the item calibration measures of ETs' level of difficulty from the ETUQ1 and ETUQ2 and the z-value from the DIF. Also, the differences in perceived relevance of the ET between the two occasions and *p*-value are presented. The higher the ET item calibration measure (in logits), the more perceived difficulty using the ET. The order of the ETs is presented according to the hierarchy in the ETUQ 2, starting with the easiest ET at the top and the most difficult at the bottom of the table.

ET	**ETUQ1 logits (SE)**	**ETUQ2 logits (SE)**	**DIF (z-value)**	**Difference in perceived relevance (%)**	***p*-value (for difference in perceived relevance)**
Answering machine, other	-0.25 (0.20)	-0.61 (0.15)	1.44	22	*p*<0.001*
Queue number system	-1.35 (0.30)	-0.57 (0.15)	-2.33	14	*p*<0.001*
Dishwasher	-0.44 (0.28)	-0.50 (0.15)	0.19	29	*p*<0.001*
Flushing device, public toilet	-1.64 (0.46)	-0.44 (0.15)	-2.48	33	*p*<0.001*
Radio	-1.05 (0.26)	-0.43 (0.15)	-2.07	5	0.235
Kettle	-1.03 (0.37)	0.42 (0.15)	-1.53	19	0.001*
Egg timer	-0.42 (0.22)	-0.41 (0.15)	-0.04	7	0.158
Elevator	-1.82 (0.41)	-0.41 (0.15)	**-3.23**	15	*p*<0.001*
Microwave oven	-0.96 (0.28)	-0.40 (0.15)	-1.76	25	*p*<0.001*
Washing machine	-0.25 (0.18)	-0.40 (0.15)	0.64	9	0.070
Coffee machine	-1.06 (0.27)	-0.38 (0.15)	-2.20	6	0.213
Stove	-1.04 (0.26)	-0.31 (0.15)	-2.43	13	*p*<0.001*
Toaster	-0.61 (0.21)	-0.29 (0.15)	-1.24	12	0.009*

Electric hand mixer	-0.73 (0.24)	-0.29 (0.15)	-1.55	11	0.030*
Tumbler-dryer	0.01 (0.20)	-0.29 (0.15)	1.20	17	0.004*
Touch-tone telephone	-1.17 (0.28)	-0.26 (0.15)	-2.86	2	0.637
Call display	-0.41 (0.27)	-0.25 (0.15)	-0.52	3	0.621
Aut. tap/dryer, public toilet	-0.66 (0.25)	-0.21 (0.15)	-1.54	21	p<0.001*
Bell push, bus	-1.36 (0.37)	-0.17 (0.15)	-2.98	30	p<0.001*
Cell phone: charge	0.01 (0.20)	-0.15 (0.15)	0.64	33	p<0.001*
Calculator	0.45 (0.15)	-0.11 (0.15)	2.64	19	p<0.001*
Cordless telephone	-0.28 (0.24)	-0.11 (0.15)	-0.60	27	p<0.001*
Cell phone: answer	0.32 (0.17)	-0.11 (0.15)	1.90	32	p<0.001*
Cell phone: call	0.20 (0.18)	-0.07 (0.15)	1.15	34	p<0.001*
ATM	0.11 (0.18)	-0.04 (0.15)	0.64	27	p<0.001*
Payment card, code	0.11 (0.20)	-0.03 (0.15)	0.56	33	p<0.001*
Internet communication	1.22 (0.21)	-0.02 (0.15)	**4.80**	42	p<0.001*
Mixer	0.16 (0.21)	0.02 (0.15)	0.54	12	0.049*
Internet banking	1.29 (0.30)	0.04 (0.15)	**3.73**	39	p<0.001*
Entry phone	-0.43 (0.29)	0.05 (0.15)	-1.47	15	0.011*
Internet information	1.08 (0.22)	0.05 (0.15)	**3.87**	41	p<0.001*
Burglar alarm	0.88 (0.41)	0.06 (0.15)	1.88	17	0.003*
Teletext	0.21 (0.19)	0.07 (0.15)	0.58	-2	0.738

Curling iron	1.16 (0.27)	0.08 (0.15)	**3.50**	-1	0.816
Smoke detector	0.25 (0.17)	0.09 (0.15)	0.71	19	*p*<0.001*
Cell phone: other services	1.76 (0.24)	0.09 (0.15)	**5.90**	30	*p*<0.001*
Remote control: other	-0.18 (0.27)	0.10 (0.15)	-0.91	5	0.404
Answering machine: own	0.86 (0.22)	0.11 (0.15)	2.81	10	0.082
Food processor	0.10 (0.21)	0.15 (0.15)	-0.19	-3	0.622
Door opener, card	0.25 (0.25)	0.15 (0.15)	0.34	30	*p*<0.001*
Digital box	-0.22 (0.49)	0.16 (0.15)	-0.74	48	*p*<0.001*
Price info scanner	-0.94 (0.52)	0.26 (0.15)	-2.22	15	0.019*
Timer	0.23 (0.23)	0.28 (0.15)	-0.18	9	0.139
Cell phone: text message	1.72 (0.29)	0.29 (0.15)	**4.38**	44	*p*<0.001*
Cell phone: fill card	0.97 (0.19)	0.37 (0.15)	2.48	4	0.505
Automatic vending machine	0.71 (0.36)	0.46 (0.15)	0.64	6	0.215
Self-service check-in airport	1.49 (0.36)	0.79 (0.15)	1.79	31	*p*<0.001*