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Everyday technologies' levels of difficulty when used by older adults with and without cognitive impairment –Comparison of self-perceived versus observed difficulty estimates

Keywords: Dementia, mild cognitive impairment, ADL, assessment, self-report, observation

Abstract:

BACKGROUND: Older adults may have difficulties in using everyday technologies, ET, e.g. micros, computers, particularly those with cognitive impairment. To guide supportive interventions, more knowledge of how to best assess ET use is needed.

OBJECTIVE: To provide new knowledge of perceived and observed levels of difficulty of ETs in older adults with and without cognitive impairment.

METHODS: Two samples of older adults (n=118 and 116) with and without cognitive impairment were assessed. One was interviewed with the Everyday Technology Use Questionnaire (ETUQ) about perceived difficulties in ET use. The other sample's observed ability to manage ET was assessed with the Management of Everyday Technology (META). Data was analyzed using a Rasch measurement model and rank-ordered hierarchies of perceived and observed levels of ET difficulty were identified, correlated and examined.

RESULTS: Findings demonstrated a correlation of 0.63 (p <.001). The upper range of both hierarchies contained more complex ETs like cell phones and computers while the lower comprised more home maintenance ETs.

CONCLUSIONS: Perceived and observed levels of ET difficulty appear as similar, yet not identical constructs. In self-reports, though, ETUQ to a great extent seems to capture levels of ET difficulty. However, in clinical practice observations of actions may guide interventions, as they can identify why an ET is difficult

Introduction

Technology in everyday life such as cell phones, coffee machines, and automatic telephone services are increasingly used by all age groups in the performance of everyday activities at home and away from home [1-5]. In this study such technology is conceptualized as everyday technology (ET) [6], incorporating the electronic, technical, and mechanical artifacts and systems that are generally used in everyday life. Previous research has shown that older adults in general, as well as persons with declining cognition due to dementia or mild cognitive impairment (MCI) use numerous ETs at home and in the community [6-8]. Fewer ETs are perceived as relevant, however, by persons with dementia or MCI compared to older adults without known cognitive impairment [8-9]. One reason for less frequent use or non-use of technology among older adults might be their experience of difficulties using technology [10-11]. Apart from the presence of cognitive deficits, difficulties in using ET may depend on other aspects, such as variability over time in managing stress and capacity to pay attention and to focus [12]. However, the difficulties may also depend on the complexity of the design of the technology [13-14]. Recent research has mostly focused on evaluating the individual ability in older adults with and without cognitive impairment in relation to ET use [8-9, 15]. To support ET use in these older adults, it is very important for healthcare professionals to gain knowledge of their clients' abilities to use ET. Still, knowledge about the level of ET difficulty when used by older adults is also needed [14] in order to gain information that can support intervention planning and product development. For a clinician, it is not enough to know that ET in general is difficult to use; information is also needed about *which* ETs are more or less challenging to use.

An important aspect when collecting information about everyday functioning in people with dementia or MCI is choosing the most valid and reliable data-collection mode. Research has indicated that people with dementia or MCI may not be fully able to give valid and reliable information about their everyday functioning [16-17]. In particular, people with dementia have been shown to overestimate their functional abilities [18-19]. The use of proxy reports (e.g. significant others) or professional assessments (using observations and/or interviews) has therefore been suggested [16-17]. However, research has also demonstrated that people with MCI may not differ to any great degree in self-reports of functional status compared to older adults without known cognitive impairments [20]. On the other hand, the use of proxy reports or professional assessments also includes challenges in order to generate valid and reliable estimations (such as rater severity impact, intra- and inter-rater reliability, and evidence of unidimensionality). More research is needed to examine the relationship between the perceived and observed information of everyday functioning in the population of older adults in order to determine the optimal mode for valid datacollection. It is important to gain more knowledge about differences in perceived and observed difficulties in ET use in order to find similarities and discrepancies in views, to support more detailed evaluation and intervention planning.

In order to explore the relationships between observed and self-reported difficulties in ET use among people with MCI or dementia (and also older adults without known cognitive impairment), assessment instruments such as the Everyday Technology Use Questionnaire (ETUQ) [21] and the Management of Everyday Technology Assessment (META) [22-23] could be used. The ETUQ gives detailed information about the relevance of different ETs and in which ETs a person has perceived difficulties, as well as about the *perceived* level of ET difficulty. The META provides observation-based information about the person's actual ability to use the ET as well as the *observed* ET difficulty. Earlier studies examining the ETUQ and the META have resulted in hierarchies of levels of ET difficulty [9, 21-22]. In these two hierarchies, ETs are rank-ordered from low to high level of difficulty based on the responses of the persons evaluated in the ETUQ-interviews and the META-observations. These hierarchies can be investigated to gain knowledge of the levels of perceived and observed ET difficulty for older adults with and without cognitive impairment. This knowledge could guide investigations and interventions involving ET use for this population, particularly for those with MCI or dementia, and could also contribute information concerning whether the data-collection modes may generate different hierarchies of level of ET difficulty. Thus the aim of this study is to provide new knowledge of perceived and observed levels of difficulty of ETs in a sample of older adults with and without cognitive impairment. It is done by investigating one ET hierarchy based on self-reported data and one ET hierarchy based on observations of ET management.

Methods

In this study, two hierarchies of the levels of difficulty for a number of ETs were compared and analyzed. The first hierarchy was generated from data in a study where the perceived relevance and difficulty of ET was investigated in a sample of older adults with and without cognitive impairment, using the Everyday Technology Use Questionnaire (ETUQ) [9]. The second hierarchy was generated from data in a study where the Management of Everyday Technology Assessment (META) [22] was used to examine the ability to manage ET in a sample of older adults with and without cognitive impairment [15].

Participants

The participants in this study comprised two samples (the ETUQ sample, n=118;AD=37, MCI=37, OA=44 and the META sample, n=116; AD=38, MCI=33, OA=42) including persons with mild Alzheimer’s Disease (AD), persons with MCI, and older adults without known cognitive impairment (OA). In the analyses the samples were treated as two groups of older adults with and without cognitive impairment. The two samples were compared regarding age, sex, MMSE score and distribution of groups. Except for a significant difference in age between the samples (ETUQ sample, m=69. 9 (SD 8.91); META sample, m=73. 1 (SD 9. 27), p=.*00*7), no significant differences were found (see Table 1). Although studies have shown that non-use/use of ET and acceptance of ET seem to be influenced by age [2, 24], research has indicated that age does not seem to have a significant influence on the perceived and observed ET use [8-9, 14-15]. As this study concerns ET difficulty based on perceived and observed ET use, we therefore decided to proceed with the analysis.

Identical inclusion criteria were used in both samples. However, the data was collected at different occasions, the ETUQ-data was collected 2008-2009 and the META-data 2006-2008. For inclusion, participants had to a) be 55 years or older, b) be engaged in everyday activities including ET use, c) have potential visual and/or hearing impairments compensated with aid(s). Potential participants with AD or MCI were excluded if they had other documented and diagnosed diseases that could cause their cognitive impairments, such as stroke or severe depression. Participants with AD (or AD combined with vascular dementia) were diagnosed by physicians based on NINCDS-ADRDA [25] and DSM-IV [26], and the participants with MCI were diagnosed based on the diagnostic criteria for MCI [27-28]. The Mini-Mental State Examination (MMSE) [29] was used to investigate the overall level of cognitive decline. The participants with AD and MCI were recruited, based on the inclusion and exclusion criteria, from memory investigation units and day-care centers for people with dementia in two urban areas in Sweden. The older adults without known cognitive impairment were recruited as volunteers through retirement organizations such as the Society of Retirees and similar networks, and through invitations from the data collectors to people they knew, who fulfilled the inclusion criteria. Approvals from the Regional Ethical Committee were obtained before the data collections were initiated (Journal no. 2005/1203-31; 2008/304-31/2).

Instruments

The ETUQ comprises 92 items, i.e. technological artifacts and services, and is administered in a 30- to 45-minute face-to-face interview. The perceived difficulty in use of the ETs that are relevant for each person is then registered on a six-step scale. The ETUQ has demonstrated acceptable internal scale validity, unidimensionality, and person response validity in studies of older adults with and without cognitive impairment [8-9].

The Management of Everyday Technology (META) was developed to assess people's ability to manage/use ET. META consists of 10 skill items assessing observable performance skills when using ETs, such as "*to identify and separate objects*", "*to choose correct button or command*" and "*to perform actions in a logical sequence*". The person's use of his/her own ET is observed and scored with the performance skill items using a three-category rating scale based on the difficulty of managing each item. Here 3=no difficulty, 2= minor difficulty, and 1= major difficulty (the scoring is further described in the manual by Nygård) [23]. In an earlier study, META was demonstrated to have an acceptable rating scale, person response validity, and ET goodness-of-fit [22].

Data-collection process

The ETUQ sample (see Table 1) was interviewed with the ETUQ in order to identify the participants' perceptions of the relevance of different ETs and their perceived difficulties to use the ETs. The ETUQ- interviews concern the perceived relevance and difficulty of the participants' own use of ET. For relevant ETs, the level of perceived difficulty is estimated by the participant. A non-relevant ET could be one that the participant does not use anymore or never has been interested in using even if it is accessible. The interviews were mostly performed in the participants' homes. Based on experiences from the first study with the ETUQ [8], it was recommended that the participants with AD should have a significant other as support at the interview session. Participants with MCI were expected to be better able to report their perceptions by themselves [19]. Four experienced registered occupational therapists (OTs) who were trained in administering and scoring the ETUQ in a valid manner collected the data. The data collection is more thoroughly described in an earlier study [9].

The META sample (see Table 1) was observed in order to assess the participants' ability to use ET with the META. Seven experienced registered OTs collected the META data. These OTs were partly the same as those who collected the ETUQ data. Each participant was observed and scored on the META performance skill items when using a minimum of two technological artifacts or services either in their home or nearby, depending on the ET. The ETs were to be chosen by the participant, relevant, and sufficiently challenging. The procedure for data collection is further described elsewhere [22].

Insert Table 1 about here

Preparatory data analysis

The ordinal data from the ETUQ interviews and the META observations were analyzed using Rasch measurement models [30], with the Rasch Winsteps [31] and FACETS software programs [32], respectively. These processes have been described more in detail elsewhere [9, 15]. The Rasch measurement model is increasingly used in the development and evaluation of assessments [33]. With the Rasch measurement model, ordinal raw scores are converted into abstract intervals through logistic transformation, and the linear relationship between persons and items can be illustrated [30]. The Winsteps was used to rank the 92 ETs in the ETUQ from the interviews with the 118 persons in the ETUQ sample. Each ET in ETUQ was assessed for at least 10 persons. The FACETS was used to rank the 68 ETs assessed, based on the observations with META of the 116 persons in the META sample. For the analysis of the collected META data, it was decided to exclude the 39 ETs that were observed when used by fewer than four participants. This decision was made as the estimation of level of difficulty with only a limited number of responses is associated with large estimate errors. Such estimation errors will then impact on the stability in further statistical analyses. In the ETUQ data, all ETs were assessed for more than four participants. Therefore no ETs in the ETUQ were excluded due to a limited number of responses. The Rasch analyses procedures also resulted in measures in logits of perceived and observed level of ET difficulty on interval scales for each ET respectively. The levels of ET difficulty are based on the responses of the persons' perceived and observed difficulties in ET use, evaluated with the ETUQ and the META. Two hierarchies of levels of ET difficulty were identified, rank-ordered from low to high level of difficulty, one based on ETUQ data and one on META data. These hierarchies are displayed in the FACETS and WINSTEPS outputs. The higher the measure in logits was, the more difficulty was perceived/observed with the ET in the sample, and the lower the measure, the less difficulty was perceived/observed. The comparisons in the primary analyses of each ET's level of difficulty were made between these two hierarchies.

Primary data analysis

For the primary data analysis, only ETs that appeared both in the ETUQ and the META hierarchies were included. This resulted in two matched hierarchies with 24 ETs each. Consequently, 68 ETs from the ETUQ and 5 ETs from the META were excluded in the analysis. The most common reason for exclusion of an ET was that the ET did not appear in both the ETUQ and the META. Also, the wordings of the ETs in the ETUQ and the META sometimes differed. These ETs were therefore excluded, for example the ETs “video” in the ETUQ and “watch a movie on the video (with remote control)” in the META were excluded in order to avoid comparing technologies that did not correspond correctly. The two hierarchies of the perceived and the observed levels of difficulty of ET gained from the ETUQ and META assessments were then analyzed, using a Pearson product-moment correlation in SPSS [34]. To decide the strength of the association, Cohen’s guidelines for social sciences were applied, 0.1-0.3= small, 0.3-0.5=medium, and 0.5-1.0 = large [35]. To determine the level of significance for the correlation a *p*-value of less than 0.05 was used. Additionally, examinations of the hierarchies were performed in order to detect patterns of similarities and differences between them (see Figure 1).

Results

Generally, an examination of the ranked hierarchies (Figure 1) showed that the upper range of both hierarchies contained more complex ETs such as cell phones and computers. Thus, these ETs were both perceived and observed as more challenging to use in this sample of older adults with and without cognitive impairment. The lower range of the hierarchies contained more home maintenance ETs like stoves, irons, and coffee makers, which were both perceived and observed as less challenging. Yet from detailed examinations of the rank-ordered hierarchies it was revealed that many of the ETs among the most difficult ones such as cell phone: call and computer: internet banking were *observed* as more difficult than they were *perceived*. In contrast, among the least difficult ETs, some ETs were *observe*d as less challenging to use by the raters than they were *perceived* by the participants, i.e. the iron and the shaver. In Figure 2, a plot of the perceived and observed measures in logits of levels of ET difficulty is shown.

Insert Figure 1 about here

Insert Figure 2 about here

The comparison of the hierarchies of *perceived level of ET difficulty* from the ETUQ and *observed level of ET difficulty* from the META in these two samples of older adults demonstrated that the two constructs are related but not identical. The results of the analysis demonstrated a Pearson correlation of .63 associated with $p < 0.001$, suggesting a large positive association (see Figure 2).

Discussion

The aim of this study was to provide new knowledge of perceived and observed levels of ET difficulty in a sample of older adults with and without cognitive impairment. In the results, it was demonstrated that the perceived and the observed levels of ET difficulty seem to be similar but not identical constructs, and there are differences in the levels of difficulty for single ETs that need to be reflected upon. However, self-reports with ETUQ to a great extent seem to capture levels of technology difficulty, so they might therefore be used in assessments and investigations in screening for cognitive impairments. To deal with differences in the levels of ET difficulty in clinical practice, it is important to consider the limitations and strengths of self-reports as well as observations in order to plan for interventions to support use of ET. Even though older adults with and without cognitive impairment to a high degree seem to be able to report perceived level of difficulty for ETs that are relevant in everyday life, there is a well-known risk that specifically those with cognitive limitations may underestimate their problems in everyday life using ET [16-19]. It is therefore important to use structured evaluations based upon actual observations as a complement to self-reports, in order to gain a more extensive and in-depth view of the level of ET difficulty in this population. Hence, the ETUQ and the META could beneficially be used together as valid and reliable assessments in the process of gaining information of levels of ET difficulty among this sample of older adults.

In the hierarchies of ET difficulty, ETs with a less complex design like the coffee maker and the electric kettle were found to be both perceived and observed to have a lower level of difficulty. These ETs are often intuitive to the user and require less cognitive effort [14]. The less challenging ETs could also be described as being more common and well-known technologies, and the participants may therefore have been more experienced in using them. It may also reflect that these ETs were incorporated to a greater extent into the everyday activities and habits of the participants [36]. It has earlier been demonstrated that ETs used daily or weekly are less challenging for this sample than those that are used more seldom [14]. However, some of these less challenging ETs such as stove and shaver were in this study perceived as more challenging than they were observed. One reason for this might be that if the ET is used daily the user might be more sensitive to discovering even minor difficulties and therefore perceive the ET as more challenging (than before) when starting to experience difficulties. In contrast, among the more challenging ETs, several were perceived to have a lower perceived level of difficulty compared to the observed level of difficulty. Examples of these are artifacts that may not be used on a daily basis, like internet banking and writing documents on the computer. That could explain why it could be more difficult to estimate and recall the challenge in using them, and they may therefore inaccurately have been referred to as less challenging to use than they presently were.

Furthermore, ETs with complex designs, such as computers, cell phones, and stereos, were generally perceived as well as observed to have a higher level of difficulty. It has previously been shown that ETs that demand the user to handle several alternative actions and give less feedback to the user are more challenging to use [13-14]. The most challenging ETs in the present hierarchies all require the user to choose the correct button or command and to identify different services and functions as well as to perform actions in logical sequences. These have been found to be among the most challenging performance actions when managing ET [21]. Additionally, all the ETs among those perceived as well as those observed as most challenging are newly-developed technologies, which may indicate that ETs are becoming more complex, as pointed out earlier by Rosenberg [37]. The reason that these newly developed ETs were perceived and observed as challenging could also be due to cohort effects, i.e. different age cohorts may differ in technological habits and use, this being a cohort of older adults [38]. In addition, it could also be explained by the fact that these ETs may not be incorporated in the body in the same way as a more well-known ET. In other words routine actions and familiar motor movements that are important for ET have not yet been integrated [6]. Nevertheless, this may affect everyday life in a negative direction as technology is an increasingly vital part of it [2, 4], and is important for participation and independence in everyday activities and in society [39]. For example, a number of services in the community often require the ability to manage more challenging ETs such as the internet and automatic telephone services.

To support ET use, evaluations of ETs' relevance and difficulty will become more and more important for health professionals in the increasingly technological society, in order to predict what technologies a person might be able to use in daily activities or to compensate for losses.

The findings in this study show that the perceived and the observed levels of ET difficulty seem to correlate to a great degree in older adult users with and without cognitive limitations. The ranking among the ET hierarchies is in many ways similar in the perceived and the observed hierarchies. However, with a correlation coefficient of .63, there are some differences in ranking, and several ETs are perceived as less difficult to use than they are observed. It is therefore important for healthcare professionals to gain information of both the perceived and the observed difficulty levels of ET to be able to plan, design, and carry out interventions to support older adults with and without cognitive impairment in use of ET. This may be specifically important in the support of ET use among people with dementia, as they often under-report difficulties in everyday functioning compared to people with MCI and those without cognitive impairments [20]. However, in this study the perceived and observed levels of ET difficulty were compared between two samples of older adults with and without cognitive impairment and not between the persons with mild AD, MCI and OA within each sample. Even though a person can perceive overall challenges in ET use it could, due to differences compared to the observed challenges in specific ETs, be important to use both data-collection modes.

Using self-reported evaluations together with observation-based evaluations as part of a clinical evaluation process before planning and implementing interventions has earlier been suggested, as this will provide healthcare professionals with as much knowledge as possible [40-41]. The information gained from the ETUQ and META assessments could beneficially be used to complement each other in clinical practice. The ETUQ can give valuable information to healthcare professionals about which ETs are perceived as relevant and difficult, and therefore important to assess with the META. In contrast, the META can then add information about the person's actual ability to perform action required and to manage using the ET. Hence, valuable information may be missed if only one of the instruments is used. Both these tools have also been extensively validated in a number of studies for different populations [8-9, 11, 15, 21-22, 42], but have not yet been used in clinical practice. In addition, healthcare professionals have emphasized in a previous study the importance of getting information about how their clients with dementia perceive their everyday lives, before initiating an intervention. If a person does not perceive that he/she is having problems in everyday occupations, this would influence how his/her problems could be met or solved in an intervention [19].

Methodological considerations

Firstly, the ETUQ and the META assessments were used in two different samples with three groups of older adults with and without cognitive impairment, respectively, and this can of course have influenced the results. However, the two samples had been recruited with identical criteria for inclusion from mainly the same cultural and societal settings. In addition, aside from a significant difference in age, dhey did not differ significantly regarding known demographical variables. In an earlier study of observed ability to manage ET, age was not found to contribute to the variance of the ability [15]. . This earlier study also showed that years of education and living conditions (living alone or cohabiting) do not seem to impact on the ability to manage ET [15]. Also, the occupational therapists who collected the data were to a great extent the same in both studies and they did not know beforehand which technologies that would be more or less difficult in the Rasch-based hierarchies which could minimize the risk for rater bias in the results.

Nevertheless, in future studies it would be better to compare the perceived and observed levels of ET difficulty in one sample of older adults. In such a study the hierarchies of ET difficulties could also be investigated on a person level to examine differences and similarities between perceived and observed levels of ET difficulty. However, the data collections for this study were performed during almost the same time span, so the levels of ET difficulty should not have been affected by different general habits in technology use or differences in the technological landscape. In this study we did not have enough information about the participants' socio-economic status and experience of each ET and therefore it was not possible to evaluate the influence of these aspects onto the findings. An earlier study has shown that the time a person has used an ET does not impact on the level of difficulty. However, that study also showed that ET used frequently is easier to use than those used more seldom [14]. So, information about how often the ETs were used might have been valuable in this study. Regarding the number of included ETs in the analyses, a higher amount of ETs available for analysis in the ETUQ and META hierarchies might have improved the analyses. However, the reason for excluding a number of ETs was to avoid the estimations of level of difficulty being associated with large estimate errors.

In summary, the present study has shown that two different data-collection modes, i.e. self-report in face-to-face interviews and systematic assessments using observations, seem to capture the difficulty of ET with a rather high congruence in samples of older adults with and without cognitive impairment. The high correlation coefficient of .63 between the perceived and the observed levels of ET difficulty shows that the constructs are similar but not identical. Because self reports to a high extent seem to capture levels of technology difficulty in this sample, the ETUQ may be a sensitive enough instrument in the screening for difficulties in technology use in investigation as well as in clinical practice. In clinical practice, the ETUQ could be used as a tool to identify which of the ETs relevant for the participant are perceived as difficult by the client. Observations with the META could thereafter be used to more in-depth assess the participant's use of these ETs, as the META provides detailed information of actions involved when the client actually uses the ET. The results of the META assessments, together with the information from the ETUQ-interviews, could then be used to plan for interventions to support use of technology, and subsequently also to evaluate the effect of such interventions.

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Table 1. Descriptions of the participants

	ETUQ sample	**META sample**	**Comparison between the samples**
Number of participants	n=118	n=116	
Groups, n	Mild AD[1]= 37 MCI[2]= 37 Older adults without known cognitive impairment= 44	Mild AD= 38 MCI= 33 Older adults without known cognitive impairment= 42	NS (Pearson Chi$^{2)}$
Age, years (SD)	69.9 (8.91)	73.1 (9.27)	*p*= 0.007 (T-test)
Gender, n (%)	Women, 64 (54) Men, 54 (46)	Women, 62 (53.5) Men, 54 (46.5)	NS (Pearson Chi$^{2)}$
MMSE, score (SD)	27.4 (2.53)	26.9 (3.30)	NS (T-test)

[1] AD= Alzheimer's disease. [2]MCI = mild cognitive impairment

Figure 1. Ranked hierarchies of the level difficulty for everyday technology from assessments in a sample of older adults with and without cognitive impairment using the Everyday Technology Use Questionnaire (ETUQ) and the Management of Everyday Technology Assessment (META). The ETs perceived/observed as most difficult are at the top of the hierarchies and the ETs perceived/observed as least difficult at the bottom.

Fig. 1

ETUQ	**META**
Most difficult	
ETUQ – perceived difficulty	**META – observed difficulty**
CD: portable	CD: portable
TV: DVD digital box	TV: DVD digital box
cell phone: text message	computer: write document
Stereo:CD with remote control	cell phone: text message
sewing machine	cell phone: call
computer: write document	computer: email
stereo	computer: search internet
cell phone: telephone book	computer: internet banking
computer: search internet	stereo: CD with remote control
computer: internet banking	radio without remote control
computer: email	stereo
cell phone: call	portable telephone
shaver	dishwasher
portable telephone	sewing machine
iron	washing machine
TV with remote control	push-button telephone
push-button telephone	coffee maker
stove	iron
coffee maker	micro
washing machine	TV with remote control
micro	cell phone: telephone book
electric kettle	shaver
radio without remote control	electric kettle
dishwasher	stove
Least difficult	

Note: The ranked hierarchies are not directly comparable; ETs on the same level in the hierarchies do not necessary have the same level of difficulty

Figure 2. Plot of perceived levels of ET difficulty in logits (ETUQ) correlated to observed levels of ET difficulty in logits (META). The marked ETs are those with the largest difference (in logits) between perceived and observed level of difficulty.

Fig. 2