Psychometric evaluation of a new assessment of the ability to manage technology in everyday life.

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Abstract

Technology increasingly influences the everyday lives of most people, and the ability to manage technology can be seen as a prerequisite for participation in everyday occupations. However, knowledge about ability and skills required for management of technology is sparse. This study aimed to validate a new observation-based assessment, the Management of Everyday Technology Assessment (META). The META is developed to assess the ability to manage technology in everyday life. A sample of 116 older adults with and without cognitive impairment were observed and interviewed by the use of the META when managing their everyday technology at home. The results indicate that the META demonstrates acceptable person response validity and technology goodness-of-fit. Additionally, the META can separate individuals with higher ability from individuals with lower ability to manage everyday technology. The META can be seen as a complement to existing ADL assessment techniques and is planned to be used both in research and practice.

Keywords: Dementia, MCI, Older adults, IADL, Instrument development, Rasch.

Introduction

There is an increased use and development of technology ongoing in the world which influences the everyday lives of most people (1). Technology has more and more become a part of the everyday life (2) and is a component of the environment regardless of whether people are able to or will use it (3). People are expected to manage a variety of technologies both in their homes and in society, e.g., remote controls, cell phones and automatic telephone services. As a consequence, the ability to manage technology has become a prerequisite to perform and participate in everyday activities and in society (3-6). On the one hand, technology can facilitate and simplify everyday occupations (7); on the other, it might also be a hindrance or a potential hazard (8). Due to the increased use of technology, the performance of a number of everyday activities has changed (1). These changes may have implications for assessment techniques in activities of daily living (ADL) and instrumental activities of daily living (IADL). Even if the management of technology targets a current and rapidly changing area influencing most peoples' everyday occupations is it commonly not considered in existing ADL and IADL assessment instruments (9). This study aims to validate a newly developed assessment instrument of the ability to manage technology in everyday life.

The area of interest for this study is the technology that exits in people's everyday lives and the concept everyday technology is used, i.e. the electronic, technical and mechanical equipment that exists in peoples everyday lives. Everyday technology may include both newly developed and common, well known, technological artifacts and services; examples are electronic household equipment, television and cash machines (8, 10).

Management of technology in everyday life

It has been shown that older adults, similar to younger adults, to an increasing extent use technology (11, 12), but several studies show that they still use technology less frequently than younger adults (4, 13, 14). One reason may be that older adults experience problems when using technology (5, 15). Other factors influencing the use of information and communication technology (ICT) and other kinds of new technology are age (12, 14), education, income, and experiences and attitudes towards technology (4, 7). Taken together, older adults' hesitance to use and difficulties to manage technology might bring about a risk for them being excluded in society (4). People with dementia who live at home may be a group at particular risk, as they have been found to experience problems in their use of both familiar and more recent technologies such as a stereo, push button telephone and shaver (8). Recent studies have also found that older adults with cognitive impairments due to dementia or mild cognitive impairment (MCI) perceive more difficulties in using everyday technology and report less technology to be relevant to them compared to older adults without known cognitive impairment (16). To be able to plan for and evaluate supportive interventions for older adults with or without cognitive impairment in everyday occupations where technology is required, it is important to know not only what the user can or cannot do but also why (17). Detailed information about difficulties and hindrances in the skills involved in management of technology is, in other words, needed (18). In this vein the assessment, Management of Everyday Technology Assessment (META) was developed to assess the management of technology use in everyday lives among older adults in general and, especially, for people with mild Alzheimer's disease (AD) or MCI.

The META is based upon the Model of Human Occupation (MoHO) (19), and empirical results from an earlier study. According to MoHO, occupational performance is influenced by the interaction between the environmental support and constraint, and the capacities of the individual. The technology is seen as part of the environment and can thereby hinder as well as facilitate the performance of everyday activities. The management of technology is also dependent of individual factors such as habits, roles, interest and motivation (19). In a qualitative, explorative study by Nygård & Starkhammar (8), older adults with mild dementia were interviewed and observed when using their everyday technology. The focus was on the participants' performance actions and reflections hereof when using everyday technology of their own choice. The result embraced a taxonomy of difficulties and hindrances that appeared during the participants' use of everyday technology, and these constituted the base for the development of items in the META. The use of qualitative methods when developing assessment instruments has, among others, been recommended by Gilgun (20) and Morse et al. (21). In another study, older adults with or without cognitive impairment were interviewed about their perceived relevance of and difficulty in use of everyday technology by use of the Everyday Technology Use Questionnaire (ETUQ) (10). The results exhibited a hierarchy among 86 different technological artifacts and services based on how easy or difficult to use the study participants perceived them to be. In assessments with the META, this hierarchy guides the rater in identifying relevant and sufficiently challenging technologies to assess for each person. With the META, older adults' ability to manage their own technology at home is assessed by observations and interviews. The META incorporates ten observable items assessing the performance skills that together are proposed to constitute the observable ability to manage technology in everyday lives, e.g., to identify and separate objects and to perform actions in a logical sequence. All performance skill items are presented in Fig. 1. In addition, data about other aspects involved in the management of technology is collected, i.e., environmental influence, the person's cognitive ability, and perceived safety and importance.

The aim of the present study is to validate the META assessment and to examine those specific performance skills that together make up the ability to manage everyday technology for older adults in general and, specifically, for people with MCI or AD. The specific research questions are: 1) What are the psychometric properties of the rating scale used in the META? 2) Do the raters demonstrate acceptable intra-rater reliability? 3) Do the performance skill items in the META and the different technologies demonstrate acceptable goodness-of-fit to the Rasch measurement model? 4) Do the participants' response patterns demonstrate acceptable goodness-of-fit to the Rasch measurement model? 5) How does the META separate participants with different abilities to manage everyday technology from each other?

Materials and methods

Participants

A sample of older adults (n=124) with varying cognitive ability, living at home was included. Participants with and without cognitive impairment were chosen as this was proposed to lead to variety in their ability. This was expected to increase reliability (22). A general inclusion criteria for all participants was (a) an age of 55 years or older. Participants should also (b) use everyday technology in their everyday lives and (c) be motivated to participate in the study. (d) Visual and hearing impairments should be compensated with appropriate devices so the assessment and interview could be carried out. Another limit for inclusion was (e) a Mini-Mental State Evaluation (MMSE) (23) score of 17-30/30 for persons with AD, 24-30/30 for persons with MCI, and 27-30/30 for older adults without known cognitive impairment as described by Fahlander building on Folstein, Folstein & McHugh (23, 24). Participants with AD or MCI were recruited from investigation units for memory deficits and daycare centers for people with dementia in two urban areas in Sweden, in collaboration with professional personnel. Diagnoses were set by physicians in clinical investigations based on the NINCDS-

ADRDA (25) and the DSM-IV (26), and the diagnostic criteria for MCI (27). Information concerning diagnosis and the MMSE score for persons with AD or MCI was gathered from their medical files at the units from which they were recruited. Older adults without known cognitive impairment were recruited through the Society of Retirees and similar networks in the Stockholm area. The MMSE evaluation of these subjects was undertaken at the same occasion as the META assessment. An ethical approval was obtained from the Ethical Committee of Karolinska Institutet before the study started (D-nr: 2005/1203-31).

Procedure

Seven raters collected all data. All were occupational therapists and received a one-day training course with general information about the META and how to use the assessment. Raters were also educated about the scoring criteria of the META and they all assessed the same four videotaped everyday technology situations before starting to collect data. In mean the raters assessed 16.6 participants each (SD 13.6, range 1-34, median 18). Data collection was, after written consent, undertaken in each participant’s home or neighborhood, depending on what kind of technology they used. The META was used to assess the participant’s ability to manage a minimum of two everyday technology situations (no maximum limit were set). The technologies assessed were the participant’s own, well-known and currently used. The assessment started with an opening conversation with a set of pre-defined questions concerning the participant´s everyday life related to everyday technology and general interest in technology. After that, the participant was observed while using technologies of his or her choice, but preferably technologies that were sufficiently challenging according to the ETUQ hierarchy (10). The performance of each skill item was thereafter scored for each chosen technology on a three-category rating scale by the rater: 3=no difficulty, 2= minor difficulty and 1=major difficulty. In Table 1, an example of the scoring of one performance skill item is shown. If the rater had doubts in choosing between two scoring categories, the lowest score was always chosen. When a performance skill item was not applicable for a particular technology, it was scored blank.

In these procedures, all raters used the detailed manual with definitions of the performance skill items and scoring criteria that has been developed to improve reliability and facilitate the use of the META (28). The manual also provides detailed recommendations of how the assessment should be administered as recommended by the American Educational Research Association, the American Psychological Association and the National Council of Measurement in Education (29).

- Insert Table 1 about here -

Data analysis

When analyzing the META raw score data, a computer application of a many-faceted Rasch analysis program FACETS (Version 3.61.0) was used (30). The Rasch measurement model converts raw score data through logistic transformation into abstract intervals, equal scales in units called log-odds probability units and logits (22). With the Rasch measurement model, the assessed persons receive measures expressed in logits on an interval scale regarding their performance ability on the assessed construct, in the case of the META ability to manage everyday technology. These ability measures can be generated regardless of the everyday technologies chosen, or how many performance skill items from the META the persons have been assessed on, i.e., the measure is considered to be test-free (31). Consequently, since all persons do not have to be assessed on the same technologies, they can choose only those that are relevant for them as long as they provide some challenge. Still their person ability measures can be compared to other persons' ability measures. Assessed performance skill items and technologies also get a measure in logits on an interval scale. These measures show the relative challenge of each performance skill item and technology. The FACETS analyses person ability in relation to technology and performance skill item challenge as well as rater leniency. The FACETS also generates goodness-of-fit statistics on assessed facets to evaluate their fit to the Rasch measurement model and perform validity analyses of the constructed scales. Goodness-of-fit statistics evaluate the degree of fit between the observed responses and the responses expected by the Rasch measurement model (22). In this validity study of the META, the ten observable performance skill items (Fig. 1) were analyzed. Eight of the 124 participants were removed from the analysis according to administration error, i.e. they were not assessed on sufficiently challenging technologies. Therefore, the Rasch measurement model could not estimate valid person ability measures (AD: n=1, MCI: n=3, and older adults without known cognitive impairment: n=4). Hence, the final sample included 116 participants (see Table 2). In total 79 different technologies, i.e., technological artifacts and services were assessed. Eleven of those technologies were excluded from the analyses since there was no goodness-of-fit statistics. This was due to the participants' lack of difficulties to use these different technologies i.e. the Rasch measurement model could not estimate technology challenge.

Initially the psychometric properties of the META rating scale were examined. According to Linacre's essential guidelines for rating scales there should, in order to obtain measure stability and accuracy, be at least 10 observations of each category in the rating scale, outfit mean square (*MnSq*) should be less than 2.0, and the average measure should advance monotonically with category (32). Thereafter, the goodness-of-fit to the Rasch measurement model for performance skill item, technology, person and rater was examined. Goodness-of-fit statistics are presented as infit and outfit *MnSq* and standardized *z*-values. The infit statistics are weighted and sensitive to performances of persons with ability close to technology or performance skill item challenge. The outfit statistics are not weighted and are more sensitive to unexpected responses and influences from outlying sources (22). In the present study infit and outfit statistics were concurrently analysed in order to get as much information as possible about the psychometric properties of the META. Acceptable goodness-of-fit was indicated by an infit and outfit $MnSq \leq 1.4$ (33) associated with $z < 2$ (22), a criteria used earlier in development of assessments of clinical observations (34, 35). Since the raters were not linked by assessing the same participants, they were assumed as equally severe and rater leniency was therefore anchored at the same severity in the analysis. Raters' acceptable goodness-of-fit was set as outfit $MnSq > 0.6$ and <1.5 (36). It is commonly accepted that 5% of the responses (i.e., person, technology, performance skill item and rater) are expected to be misfits by chance with z-values less than 2. In the present study, therefore, 95% of the responses were supposed to demonstrate acceptable goodness-of-fit to the Rasch measurement model and not to be a threat to validity (22). Because the META only has ten performance skill items, the goodness-of-fit criterion for these was no more than one performance skill item demonstrating misfit (37). All measures generated from the Rasch analyses have error estimations, defined as Standard Error (*SE*). The *SE* indicates the replicability and precision of the measures for the sample assessed (22). Finally, to describe reliability of the assessment for this sample, the person separation index and person reliability index were examined. The person separation index is the number of different groups with statistically different levels of ability, e.g., to manage everyday technology that can be identified in the sample. The lowest recommended value for an acceptable separation is 1.5 (38). The person reliability index is interpreted similarly to Cronbach *α.* In classical test statistics, an index of 0.70 is a minimal acceptable value (39) and was used in this study.

- Insert Table 2 about here -

Results

The 116 participants were assessed when using between two and 10 everyday technologies each (mean=3.64, SD=1.49). The distribution of measures for person ability, technology challenge and performance skill item challenge is shown in Fig. 1.

- Insert Figure 1 about here -

Rating scale analysis

The results of the analysis of the rating scale showed no disorder of the steps in the rating scale or unacceptable outfit *MnSq* values (see Table 3). The rating scale was considered acceptable and the data analysis therefore continued with fit statistics analyses of the evaluated facets.

- Insert Table 3 about here -

Intra-rater reliability

All raters demonstrated acceptable goodness-of-fit to the Rasch measurement model with outfit *MnSq* between 0.65-1.25. This indicates acceptable consistency (intra-rater reliability) within raters.

Internal scale validity

Performance skill item challenge measures in the META represented a range from 0.92 to -1.75 logits (mean=0.00, *SE*=0.20), which indicate that both less and more challenging items are included (Fig. 1). The ten performance skill items were used between eight and 394 times (mean=269.1, median=366.5, SD=147.5). Two items; manage a series of numbers/letters and coordinate different parts of a technology, demonstrated unacceptable goodness-of-fit to the

Rasch measurement model on infit respective outfit (see Table 4) and the META was therefore considered to have an unacceptable internal scale validity.

Technology goodness-of-fit

Technology challenge measures ranged from 1.60 to -1.82 (mean=0.00, *SE*=0.50), which indicate that both less challenging and more challenging technologies have been evaluated. It was therefore concluded that the META can be used in a valid manner to assess the management of technologies using a wide range of technology challenges. Out of the 68 technologies, 65 (96%) demonstrated acceptable goodness-of-fit to the Rasch measurement model. The technologies that did not demonstrate acceptable goodness-of-fit were: managing a burglar alarm, an electric kettle and a TV with a remote control (see Table 4). Managing a burglar alarm demonstrated misfit on infit and outfit and managing an electric kettle and a TV with a remote control on outfit.

Person response validity and precision

The person ability measures, 4.25 to -0.77 (mean=1.56, *SE*=0.49), represent a wide range of abilities to manage everyday technology. Of the 116 participants, 113 (97.5%) demonstrated acceptable goodness-of-fit to the Rasch measurement model and three demonstrated unacceptable values on outfit MnSq and z values (see Table 4). This indicates that the META demonstrates acceptable person response validity in this sample of older adults with and without cognitive impairment.

- Insert Table 4 about here -

Person separation and reliability

A person separation index of 1.68 indicates that the META can separate at least two groups with different levels of ability to manage everyday technology (38). Person reliability index was 0.74 and this indicates an acceptable replicability of person ability ordering if the same sample would be assessed on a parallel set of performance skill items representing the same construct.

Discussion

The purpose of the study was to examine the psychometric properties of the META, developed to assess the skills that make up the ability to manage everyday technology in a population of older adults in general and, especially, for people with mild AD or MCI. The results provided evidence for acceptable rating scale, acceptable intra-rater reliability (consistency) and acceptable person response validity but unacceptable internal scale validity. Performance skill items, technologies, persons and raters generally demonstrated an acceptable goodness-of-fit to the Rasch measurement model, although some responses did not. The results also indicated acceptable person separation index and person reliability index for this sample. Possible reasons and explanations for performance skill items, technologies and persons that demonstrated misfits as well as person separation index will be discussed.

Two performance skill items in the META, manage a series of numbers/letters and coordinate different parts of a technology, demonstrated an unacceptable goodness-of-fit to the Rasch measurement model. The high infit goodness-of-fit statistics for managing a series of numbers/letters and outfit goodness-of-fit statistics for coordinating different parts of a technology indicated unexpected responses. A detailed examination of the most unexpected responses in data revealed lower observed scores than expected by the Rasch measurement model (22). One possible explanation for misfitting goodness-of-fit statistics for managing a series of numbers/letters could be that this performance skill item is required in the use of a variety of different technologies, e.g. in telephone numbers, login codes to computers and cell phones, and text television codes. Managing a series of numbers/letters may thereby differ in challenge more than other items due to these variations and this could cause the unexpected responses. Moreover, Wright (40) suggests that ambiguous wording of an item might cause misfit. Hence, if this performance skill item would be divided into two more specified and more clearly defined performance skill items perhaps more precise assessments could be made. Similarly, a number of unexpected responses for coordinating different parts of a technology were demonstrated during assessments of managing a TV with a remote control. In other technologies where coordinating different parts of a technology is required, e.g., push-button telephones or microwave ovens, it may be more obvious how to coordinate different parts of the technology than it is to coordinate a remote control with the TV. This suggests that this performance skill item may perhaps be divided into two: one assessing more concrete coordination of different parts of a technology and one assessing more distant coordination. Nevertheless, since two performance skill items in the META did not demonstrate acceptable fit to the measurement model this highlights a potential problem and might be a sign of disturbance in the scale as some items might represent other constructs. In future studies with the META, the performance skill items in the META need to be reconsidered according to the suggestions above and further evaluated.

Only three of the technologies assessed with the META (4 %) did not demonstrate acceptable goodness-of-fit: managing a burglar alarm, an electric kettle and a TV with a remote control.

Managing a burglar alarm was misfitting on infit values, which implied unexpected response patterns for participants with an ability which was close to technology challenge, and outfit values. For example, one person with the ability to manage everyday technology near to the challenge for managing a burglar alarm demonstrated higher ability than, and this might have caused the misfitting values. Such unexpected high ability may, for example, follow if management of a certain technology would for some reason be very important for a person (41). The less challenging technologies managing an electric kettle and managing a TV with a remote control demonstrated high outfit statistics. An in-depth examination of data indicated that most misfits seem to derive from a few single individuals with overall high competence. As outfit statistics are sensitive to such unexpected responses, misfitting values may be explained by unexpected responses from these few participants (22), this might not be a threat to scale validity.

The participants demonstrated high goodness-of-fit to the Rasch measurement model, which indicates that the META can be applied in a comparable sample with similar, expected results. However, three participants (2.5%) demonstrated misfit on outfit values which indicate unexpected responses (22). All three participants unexpectedly failed to manage technologies with challenge measures much lower than their person ability measures. An examination of unexpected responses and other information on these misfitting participants suggests a variety of possible explanations for the misfitting values. For example, one participant reported a time of non-use for a technology, which can be an indication of the technology not being relevant for that person anymore and thereby causing the unexpected difficulties.

The person separation index of 1.68 indicates that the META can divide the present sample into at least two groups with different ability levels (38). This rather low person separation can be a result of sample homogeneity. If a sample is homogeneous, person ability measures might not have sufficient wide range to demonstrate a sufficient hierarchy of ability to manage everyday technology (22). In fact, almost 70% of our sample had a person ability measure that differed no more than one logit from person ability mean (1.56), and this may indicate homogeneity as an aspect contributing to the quite low person separation. The rather low person separation index in this sample might also be explained by person ability measures not targeted to technology and performance skill item challenge. As shown in Fig. 1, person ability measures are generally higher than technology and performance skill item challenge measures. This suggests that the META may not easily discriminate between people with high ability to manage everyday technology since there are few technologies and performance skill items targeting high ability. This was also found by Rosenberg et al. (16) when assessing perceived relevance of and overall difficulty in using everyday technology among people with or without known cognitive impairment. However, the META was specifically developed for clinical use among people with mild AD or MCI who generally perceive everyday technology to be more challenging to use than people with no known cognitive impairment (16), and the less able participants in this study were shown to be better targeted to performance skill item challenge in the META. Nevertheless, in order to increase person separation index for the META, more challenging technologies and performance skill items may be needed (42).

The person separation index is known to be connected to *SE* (22). In the analysis, relatively large *SE*s for person ability, and technology challenge measures were found. One explanation for this might be that a large number of technologies were assessed only in one or two persons, resulting in difficulties to estimate precise technology challenge measures.

Consequently, an increased sample size in future studies might decrease technology challenge measures *SE* (22). In our sample, participants with a higher ability to manage everyday technology had a larger person ability measure *SE* than participants with a lower ability, and this may be caused by too few targeting technologies and performance skill items. One way to reduce the person ability measure *SE* may be to expand the META assessment with performance skill items more targeted to participants (22). In addition, an increased number of categories in the rating scale might be helpful to increase both person ability and technology challenge measures *SE*.

An examination of how the different categories in the rating scale have been used shows that Categories 3 (no difficulty) and 2 (minor difficulty) were used in over 90% of the scorings (see Table 3). To make assessments with the META more precise, these two categories could be divided into three. In another ADL assessment, the Assessment of Process and Motor Skills, AMPS, the performances skills are rated with items on a four-category rating scale (43). The categories used in the AMPS are competent, questionable, ineffective and deficit. Such a four-category rating scale might be one way to increase specificity of measures generated by the META. A four-category rating scale in the META may be easier to use clinically, since an assessment with a four-category rating scale might give more detailed information about performance of activities and therefore be able to guide an intervention better than an assessment with a three-category rating scale.

There are some methodological limitations in this study that should be elucidated. Obviously, participants with a high ability to manage everyday technology were not always assessed on enough challenging technologies i.e., person ability was not always well targeted to technology and skill item challenge. A reason for this might be administration error, i.e., raters did not assess sufficiently challenging technologies. Another explanation could be that older adults may not perceive more challenging technologies to be relevant for them, even if they have access to them (10, 12, 14). To make the META able to better separate people with high ability from people with lower ability to manage everyday technology, more challenging technologies should be included and assessed in future studies. Moreover, almost all participants in the study lived in an urban or suburban environment. As the living environment might affect the management of everyday technology (44), future studies with the META should take the living environment into account and compare management of technology in people living in different contexts. To summarize, in future revisions of the META, more challenging technologies should be assessed, additional performance skill items should be included and an increased number of categories should be defined in the rating scale.

Even though the META needs further evaluation of the psychometric properties and a revision of performance skill items and rating scale, the results of this study show that the META has a potential to be used both in research and in occupational therapy practice. The META provides information not only regarding if a person can or cannot manage everyday technology but also about the specific performance skills that are required to manage the technology. Such detailed information about performance skills in management of everyday technology in combination with information achieved by using existing assessments of ADL and IADL would be important when planning and evaluating interventions in everyday lives for people with dementia. Since only the performance skill items in the META are mandatory to use in the META assessment and the technology is chosen by the participant it will be possible to continuously include assessments of new and more challenging technologies, as long as these technologies fit the measurement model.

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Table 1**.** Scoring example of a performance skill item in the Management of Everyday Technology Assessment. All performance skill items are scored based on the same principles.

Performance skill item	Performance	Category	Reason
Identify and separate objects	Picks up without hesitation the remote control even though there is a calculator lying next to the remote control.	3	No difficulty
	Picks up the calculator to turn on the TV but notices almost immediately that it is a mistake and picks up the remote control instead.	2	Minor difficulty
	Confuses the remote control with the calculator repeatedly or needs help to find the correct piece of technology.	1	Major difficulty

Table 2. Characteristics of the participants in terms of age, sex, civil status and cognitive status.

Groups	Age			Sex, n (%)		Civil status, n (%)		MMSE[c] score (max. 30)		
	M	SD	range	men	women	cohabiting	single	M	SD	range
AD[a] n=38	75	9.09	58-89	18 (47)	20 (53)	20 (53)	18 (47)	23.53	3.26	17-29
MCI[b] n=33	70	8.40	57-87	19 (58)	14 (42)	25 (76)	8 (24)	27.52	1.87	24-30
Without known cognitive impairment n=45	73	9.73	55-92	16 (36)	29 (64)	23 (51)	22 (49)	29.27	1.07	27-30

Notes: [a]AD= Alzheimer's disease, [b]MCI=mild cognitive impairment; [c]MMSE= mini mental state examination

Table 3. Analysis of the three-category rating scale in the Management of Everyday Technology Assessment.

Category	Count, n (%)	Average Measure[a]	Infit MnSq[b]
1 Major difficulty	235 (9)	0.04	1.10
2 Minor difficulty	509 (19)	0.95	0.90
3 No difficulty	1,947 (72)	2.18	0.90

Notes: [a]Average measure= Indicator of the context in which the category is used. Higher categories in the rating scale are modeled to reflect more of the underlying variable. The average measures should advance monotonically with category. [b]MnSq=Mean square, should be less than 2.0.

Table 4. Performance skill items, technologies and persons demonstrating misfit to the Rasch measurement model. Presented with measure of challenge/ability, standard error (*SE*), infit and outfit *Mean Square* (*MnSq)* and standardized *z* values.

Misfitting performance skill items	Measure	SE	Infit *MnSq*	Infit *z*	Outfit *MnSq*	Outfit *z*
Manage a series of numbers/letters	.09	.23	1.51	2.70	1.56	1.90
Coordinate different parts of a technology	-.55	.16	1.01	0.10	1.79	2.50
Misfitting technologies						
Manage a burglar alarm	.82	.65	2.21	2.60	2.30	2.10
Manage an electric kettle	-1.22	.55	1.35	0.70	3.86	2.50
Manage a TV with a remote control	-.97	.14	0.93	-0.4	1.76	2.20
Misfitting persons						
Participant 0231 (without known cognitive impairment)	1.74	.49	1.69	1.70	4.60	3.90
Participant 1027 (mild cognitive impairment)	1.57	.69	1.67	1.10	3.28	2.00
Participant 2082 (Alzheimer's disease)	1.32	.46	1.29	0.70	6.12	3.80

Note: Not acceptable goodness-of-fit was indicated by an infit and outfit *MnSq* > 1.4 associated with *z* > 2.