Abilities to Use Technological Communication Tools in Aging: Contribution of a Structured Performance-Based Evaluation

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Abstract. New technologies remain little used by the elderly and their impact is not sufficiently evaluated. Our research aims to evaluate the potential benefits associated to the use of communication tools and specifically with digital applications on touch pad. The present research compared the ability to use a fixed or mobile phone and a touchpad, by 25 young adults and 25 older people, living in the community and without neurological or psychiatric history. Compared to younger adults, aging people produce more commission errors and need more assistance to correct themselves, especially for the most recent technologies. The data appear to validate a hierarchical assistance model to help aging people using technological communication tools. They should be better assisted in a strategic way, using reinsurance and specific cueing. The results also indicate that the combination of a specific observation grid for standardized daily living tasks is especially sensitive to evaluate autonomy loss in aging.

Keywords: Telephone · Performance-based assessment · Older person · Touchpad · Errors · Human assistance

1 Introduction

According to the World Health Organization (WHO) [1], the percentage of persons aged 60 years and over is expected to double between 2000 and 2050. Besides, the number of dependent people increases with age; Veber and Morel [2] reported 8 % of dependent people among adults of 60-year-old and over against more than 60 % beyond 95-year-old. At the same time, the number of cognitively impaired individuals is brought to grow [1]. As a consequence, the lengthening of life expectancy constraints society to face with a real challenge, specifically with the aim to support elderly dependent people, or at risk of loss of autonomy, at home. The wide scope of gerontechnology may provide innovative solutions both to promote assessments of daily living and to overcome the disability in activities of daily living (ADLs) [3].

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Even if it's a common technology, the telephone is a communication tool essential to maintain independence and autonomy in aging people living in the community. Indeed, it enables to keep in contact with people living far away as well as to organize home-help services or call for help if needed, contributing to ensure personal safety [4], and keeping some control over his/her own life [5]. Furthermore, the ability to use the phone is identified as sensitive to early cognitive decline associated with dementia disorders [6]. More generally, the adaptation to new communication technologies becomes unavoidable to remain actively involved in our society. In addition, learning and using computers may develop the sense of well being, may stimulate the world understanding, and increase the sense of belonging of aging people [7]. Among these technologies, tablets offer both the opportunities of phone and computer, and then may be quite interesting. Indeed, for the elderly, the touch-sensitive screen seems to present the advantage of simplicity of use, compared with the computer [8, 9]. However, new technologies remain little used by the elderly, and their impact is not sufficiently evaluated, even in healthy individuals.

When developing easy-to-use technologies, adapted support to assist aging user in handling of the technology is an apparent need to encourage its adoption [10] and particularly to increase perceived sense of control, which strongly determines technology adoption [11]. Moreover, high quality training with a focus on establishing or restoring a person's confidence in technology but also in his/her own capacities would facilitate learning [12]. Thus, it is essential to promote education and learning, with seniors, their family, and professional caregivers. However, an adapted and effective support could not exist without a fine evaluation of the difficulties' nature and of the cues provided during the task.

A wide variety of tools can be used to assess ADLs: self- and proxy-reported, performance-based measures, as well as direct observation at home. Paper-and-pencil questionnaires allow easy and quick use but have been criticized for their lack of ecological validity: Items often rate a global functioning in an activity and can sometimes only be assumed to respond on a all-or-nothing basis, the measure do not then reflect the nature of the difficulty, the gradual nature of the disorder, or its heterogeneity [13]. Moreover, the activities are generally little or globally described, allowing the interpretation of respondent comprehension and appealing also to his/her memory or retrospection. Results obtained with self-reported measures may also suffer from bias, like over or underestimation of the abilities [14, 15]. In order to propose individually adapted readaptation activities, we need a more detailed ADLs measure, analyzing the task step by step and enabling to give the adapted cue at the right time. Direct observation tools enable to collect information on subject's performance by evaluating effective capacity, using real-world situations. They are considered to be less influenced by the education and cultural level, and could be more valid and objective measures than self-reports [15]. However, they have certain disadvantages: a major one is the time required, one hour and a half on average, for the observation [16]. In addition, data collection may require a suitable room with a more or less substantial specific material, a greater training of the observer, or video recording, making these assessment instruments barely usable in clinical practice [15]. Nonetheless, they provide accurate and relevant information on the patient's functioning, particularly useful in case where there is no family support.

Many researchers using performance-based measures have taken an interest on the type of errors occurring during the task execution. To allow for subtle ADLs analysis, Schwartz et al. [17–19] proposed two main errors categories: omission and commission (including objects substitution, action-addition, sequence errors like anticipation-omission, performance of a step in reverse order or perseveration). Several studies included this error taxonomy [20, 21]. Anselme et al. [22] did too and added initiation errors: when the participant does not start spontaneously the activity, for any reason. According to Giovannetti et al. [21], action-additions while linked to commissions or omissions will be conceptually different and have to be distinguished. Healthy people are likely to produce errors, although less than people with a neurocognitive disorder, and mostly of commission type [23], nonetheless omissions should be likely to be produced by healthy young participants in less familiar tasks [24]. Furthermore, Bettcher et al. [25] highlighted the significance of self-correcting ability as a relevant indicator of living alone at home. Indeed, the number of errors being never zero, detect and correct them is therefore of special importance. Different levels of hierarchical assistance can be provided to help people who do not correct themselves. Neistadt [26] proposed to make a distinction between general verbal (providing guidance with a series of questions) and physical assistance. This distinction has been reproduced in the analysis grid from the Profinteg tool [22, 27]. The authors added specific ("Would this not be written somewhere?") and total verbal assistances ("You have to…"). This enables to determine which assistance is adapted to the subject's difficulties, while exploiting his/her potential.

In that context, our research aims to precise the actual capacity of healthy aging persons to use fixed and mobile phones, and mobile tablet computers compared to young adults. We analyzed their performances in three usual tasks, considering the errors generated as well as the requested and provided cues.

2 Method

2.1 Participants

The study population consisted of two healthy groups, constituted by people living in the community and with no known cognitive impairment. For inclusion in the study, participants had to be between 18 and 40 old for the "younger" group and 64 or older for the "older" group, as well as having French as mother language. Visual and/or hearing impairments were exclusion criterion except if they could be compensated with technical aid(s). Other exclusion criteria were: reported history of psychiatric disorders or stroke, refusal to be filmed, or scoring less than 26 at the Mini Mental State Examination (MMSE) [28, 29]. We also considered the symptoms of depression with the 20-items French version of the Center for Epidemiological Studies Depression Scale (CES-D) [30], due to the possible impact of depressive symptoms on attention. Education status may reflect cohort effects. So, we administered a vocabulary questionnaire (Mill-Hill part B, French version) [31] as an indicator of the socio-educational level.

Fifty participants were met, 25 in each group. Three were excluded from the "older" group due to exclusion criteria: one because of a disabling visual condition and the two others because their MMSE score was 23 and 25.

Demographics of the samples are presented in Table 1. The cognitive level was significantly different ($t(31.797) = 3.34$, $p < .01$), which is not surprising if we consider that the aging process results in a slight decline of these performances. As expected, the "older" group had a statistically significant high vocabulary level ($t(44.94) = -4.21$, $p < .001$). No significant differences were found between groups in relation to years of education and level of depressive symptoms.

Table 1. Characteristics of the participants

	Age		Education (years)		MMSE		CES-D		Mill-Hill B	
	M SD	Range	M SD	Range	M SD	Range	M SD	Range	M SD	Range
"Younger" n = 25	31.8 6.8	18–40.4	14.5 3	9–20	29.2 0.8	28–30	11.1 5.6	5–25	35.6 3.0	28–41
"Older" n = 22	73.5 6.6	64.2–88.7	13.7 3.4	7–20	28.0 1.4	26–30	15.3 8.8	0–28	39.0 2.6	33–43

2.2 Procedure

A questionnaire was administered to collect demographic and technology habits information, including frequency of use. We also assessed global cognitive functions (MMSE), vocabulary level (Mill Hill part B) and depressive symptoms (CES-D). Finally, in order to meet the objectives of the research, we evaluated and compared the capacity of use in fixed phone, mobile, and tablet. The evaluation was individual and without time limitation. The analysis of the answers was based on verbal and non-verbal elements, and subjects were videotaped while they were using the three communication tools. Videos will next be analyzed by means of a specific scorecard.

The local ethic committee approved the research, and all participants signed the review board-approved consent form providing permission to videotape

2.3 Materials

To assess the capacity of use in the three communication tools, we adapted the hierarchical tasks of the telephone use domain from the Observed Tasks of Daily Living-R (OTDL-R) [32], a performance-based assessment tool of IADL. Participants had to perform three tasks of increasing difficulty and involving their ability to use the three technologies in a usual everyday activity: search for a phone number in a document before dialing it. For the third task, they also had to look for the date of a scheduled appointment in a medical letter then to check it in a diary. The evaluation tasks differed by the structuring level of material mentioning the phone number to dial and by the level of executive constraints linked to the organization and to the control of the steps required to complete the task. We focused on difficulties in using and understanding. We always assessed the technologies in the same order: from the simplest or more common (i.e. fixed) towards the more complex or less common (i.e. tablet). To analyze participants' performances, we used an adapted scorecard developed on the basis of the Profinteg grid [22]. To construct the analysis grid, we sequenced each task, establishing the nature, the number and the chronological order of the necessary steps required to carry out the activity, thus defining a reference script. We were also interested in the types of errors likely to be made (Table 2) and hierarchically listed the cues that might be provided during the task (Table 3). The order was pre-determined, based on a graduated set of responses: from the less informative to the most informative one. The participants were given no indication until they were stuck, asked for help, or made a mistake. According to Bettcher et al. [25], we decided to account the number of self-corrections as well as of external control strategies.

Table 2. Errors typology

Error type	Description
Initiation	The participant does not spontaneously start the activity after 15 s (for any reason) or says, “I don't know”.
Omission	The participant does not execute a step (including forgetting of the contents) (e.g. He/she doesn't read the number). To be considered as an omission, an error must not be a consequence from any other error type.
Erroneous execution	Realization in an incorrect, inappropriate way, or not at the right time (e.g. He/she make a mistake in dialing the number or doesn't read the right number), including perseverations: A step is executed more than once (e.g. Read the number, look at the instructions and then read again the number)
Action-addition	Performing an action that cannot be considered like a necessary step to complete the task (e.g. write the appointment in the diary)

Table 3. Typology of the provided cues

Cue type	Description
General	Encouraging to continue or advising the participant of an error but without specified which one and where (e.g. “Be careful!”- “Hm hm”)
Specific	Verbal indication on the nature of the error but without providing information about what needs to be done or how to do it (e.g. “You are forgetting something.”)
Total	Detailed explanation of what the participant has to do (e.g. “Press the star * key”)
Gestural	Showing the right key or number
Physical	Performing the step for the participant (e.g. Press the star key)

2.4 Statistical Analyses

To identify a difference in the use of communication technologies and age effect, we used a multivariate analysis of variance with repeated measures (MANOVA), under the assumption that there is a gradual progress of the technologies' complexity. First, we analyzed errors and assistance means. Then, we considered the performances more in details and compared the distributions of each type of errors and cues.

3 Results

3.1 General Results

We explored the capacities to use three communication technologies (fixed and mobile phones, and tablet computer) by "younger" and "older" people, considering the number of errors, cues, self-corrections, and control strategies. Repeated-measure MANOVA analyses confirmed that there were significant multivariate effects for age group ($\lambda = .320$, $F(4,41) = 21.8$, $p < .001$), technology ($\lambda = .225$, $F(8,37) = 15.9$, $p < .001$), and for the interaction between age and technology ($\lambda = .270$, $F(8,37) = 12.5$, $p < .001$). Univariate between-group analyses revealed that the "older" group significantly produced greater total error ($F(1,44) = 64.93$, $p < .001$), needed more cues ($F(1,44) = 50.66$, $p < .001$), and used more control strategies ($F(1,44) = 21.78$, $p < .001$). Within-group univariate analyses indicated significant differences between technologies for the sum of errors ($F(1,1.65) = 58.87$, $p < .001$) and cues ($F(1,1.68) = 35.01$, $p < .001$).

There were significant linear and quadratic effects of the technologies' complexity for the total number of self-corrections (respectively, $F(1,44) = 24.00$, $p < .001$; $F(1,44) = 11.81$, $p < .001$), errors ($F(1,44) = 85.07$, $p < .001$; $F(1,44) = 12.47$, $p < .001$), and cues ($F(1,44) = 51.55$, $p < .001$; $F(1,44) = 4.00$, $p = .05$). There was also a linear effect of the interaction with the age factor for errors ($F(1,44) = 50.73$, $p < .001$) and cues ($F(1,44) = 62.97$, $p < .001$): that is a significant major effect for aging people (Fig. 1).

Further analyses showed that, when using the tablet, "younger" produced significantly more errors (fixed: $t(24) = -2.63$, $p = .015$; mobile: $t(24) = -3.24$, $p < .01$) and self-corrections (fixed: $t(24) = -2.91$, $p = .008$; mobile: $t(24) = -2.70$, $p = .012$). They also needed more assistance with the fixed phone than with the mobile ($t(24) = 3.26$, $p < .01$). Other differences (Table 4) were not significant.

"older" needed significantly more cues with the tablet [mobile: ($t(20) = -4.72$, $p < .001$); fixed: ($t(20) = -7.19$, $p < .001$)], and with the mobile than with the fixed phone ($t(20) = -4.28$, $p < .001$). Similarly, they produced more errors with the tablet (mobile: $t(20) = -600$, $p < .001$; fixed: ($t(20) = -8.31$, $p < .001$) and with the mobile compared to the fixed phone ($t(20) = -4.11$, $p < .001$). The number of self-corrections was also significantly more important with the tablet (fixed: $t(20) = -3.77$, $p < .001$; mobile: $t(20) = -3.65$, $p < .01$). Other differences (Table 4) were not significant.

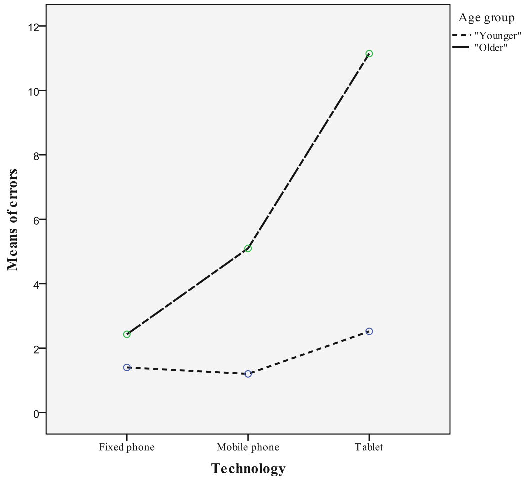

Fig. 1. Line graph – means of errors across technologies by age group

Table 4. Errors, cues, self-corrections, and control strategies scores by technology type and age group.

	"Young" mean (SD)	"Old" mean (SD)
Total number of errors		
Fixed phone	1.4 (1.6)	2.4 (2.0)
Mobile phone	1.2 (1.0)	5.1 (3.7)
Tablet computer	2.5 (1.9)	11.1 (4.4)
Total number of cues		
Fixed phone	4.4 (3.1)	8.9 (5.6)
Mobile Phone	2.3 (2.0)	18.7 (13.4)
Tablet computer	3.2 (2.9)	33.8 (20.2)
Total number of self-corrections		
Fixed phone	.2 (.5)	.2 (.4)
Mobile phone	.2 (.4)	.2 (.4)
Tablet computer	.7 (1.0)	1.3 (1.3)
Total number of control strategies		
Fixed phone	2.0 (1.4)	3.8 (2.7)
Mobile phone	1.8 (1.5)	4.5 (2.7)
Tablet computer	1.6 (1.6)	4.3 (2.5)

3.2 Errors and Cues Patterns

We explored in more details the errors produced (initiations, omissions, erroneous executions and action additions) and the assistance provided (general verbal, specific, total verbal, gestural and physical) across the three technologies for "younger" and "older". Repeated-measure MANOVA analyses highlighted significant multivariate effects for age group (λ = .35, F(4,41) = 19.33, p < .001), technology (λ = .27, F (8,37) = 12.66, p < .001), and for the interaction between age and technology (λ = .37, F(8,37) = 7.94, p < .001) for errors, as well as for assistance (respectively: λ = .40, F (5,40) = 12.17, p < .001; λ = .35, F(10,35) = 6.43, p < .001; λ = .314, F(10,35) = 7.66, p < .001). Univariate between-group analyses showed that "older" produced overall significantly more omissions (F(1,44) = 30.01, p < .001), erroneous executions (F(1,44) = 64.34, p < .001), and initiations (F(1,44 = 7.10, p = .011) than the "younger" group. They also needed more general (F(1,44) = 47.18, p < .001), specific (F(1,44) = 61.42, p < .001), total verbal (F(1,44) = 25.94, p < .001), and gestural assistance (F(1,44) = 5.63, p < .001).

Within-group univariate analyses indicated significant differences between technologies for the number of executions (F(2,88) = 69.91, p < .001) and action additions (F(2,88) = 6.38, p < .01) produced, as well as for general (F(2,88) = 30.44, p < .001), specific (F(2,88) = 32.99, p < .001), total verbal (F(2,88) = 13.92, p < .001), and gestural assistances (F(2,88) = 3.55, p = .042). Further analyses showed that the "younger" group produced only initiation errors with the fixed phone (m = 0.16, SD = 0.37, t(24) = 2.138, p = .043), and significantly more erroneous execution errors with the tablet (m = 1.84, SD = 1.40) than with the fixed (m = 0.76, SD = 1.23, t(24) = −3.36, p < .01) and mobile (m = 0.56, SD = 0.65, t(24) = −4.67, p < .001) phones. The "older" group produced significantly more omission (m = 2.05, SD = 1.02, t(20) = −3.02, p < .001), erroneous execution (m = 8.05, SD = 3.40, t(20) = −8.92, p < .001) and initiation errors (m = 0.71, SD = 1.19, t(20) = −2.55, p = .019) with the tablet than with the fixed phone (respectively, m = 1.14, SD = 1.08; m = 1.09, SD = 1.27; m = 0.14, SD = 0.35). The difference between erroneous execution errors scores was also significant between mobile phone (m = 3.10, SD = 2.45) and tablet (t(20) = −6.38, p < .001) as well as fixed phone (t(20) = −4.22, p < .001). Other differences were not significant. Figure 2 represents significant differences between groups.

"Older" group's scores of general and specific verbal assistance were significantly different between all the technologies (p < .001). Total verbal assistance also increased significantly with the technology [fixed phone (m = 0.14, SD = 0.35) compared to mobile phone (m = 0.67, SD = 1.20, t(20) = −2.25, p = .036) compared to tablet (m = 1.86, SD = 1.82, t(20) = −2.61, p = .017)]. By contrast, the "younger" group needed only more general verbal assistance with the fixed phone (m = 3.8, SD = 2.5) compared with the mobile (m = 1.76, SD = 1.33, t(24) = 3.89, p = .001). Finally, needs were also different between groups (Fig. 3).

4 Discussion

We compared the ability to use a phone (fixed and mobile) and a tablet computer considered across the total number of errors, cues, self-corrections and control strategies, by young and aging people, living in the community and without neuropsychological or psychiatric history. Every kind of errors occurs, even in young participants. Nevertheless, older participants produced more errors than younger adults and needed

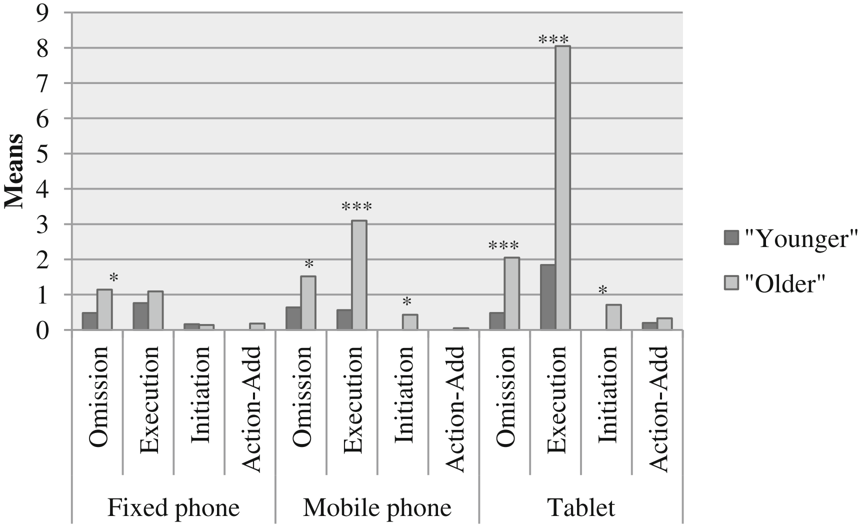

Fig. 2. Differences between the two groups in the distribution of error types for the three technologies (*p < .05; **p < .01; ***p < .001).

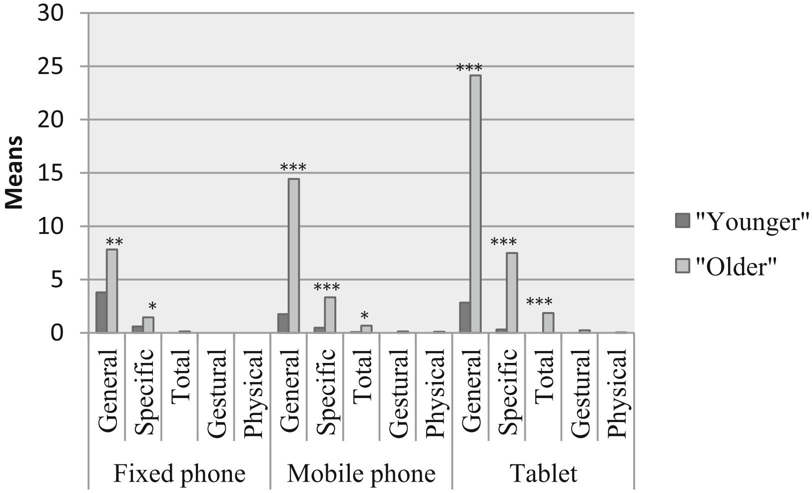

Fig. 3. Differences between the two groups in the distribution of assistance types for the three technologies (*p < .05; **p < .01; ***p < .001).

more assistance. In particular, the results highlighted that aging people produced more omission, execution and initiation errors than young adults. Errors are mostly erroneous execution ones, like reported in previous research in healthy aging population [22]. Nonetheless, we only considered the sum of errors, not the proportion of each error type which might be helpful to confirm patterns suggested by Fig. 2 and to verify if omission errors are more frequent in healthy adults when executing less familiar tasks [24]. Unexpectedly, we did not observe any differences concerning omissions for younger participants. According to our results, the distinction between omissions, commissions, initiations and action-additions, mainly used with impaired people, seems to be sensitive in healthy aging people. Nevertheless, we did not consider the commission error category in details. Yet, it includes several types of errors [17–19], like errors of quality. More explorations are needed considering the number of errors of quality identified, while they were relatively rare in previous research [20]. It may be related to the tablet handling, in particular the use of the touch screen may cause quality errors. It would then be insightful to explore if the nature and the number of errors produced are linked to the specific constraints of the situation (assessment context, documents to read, or technology to use).

Our findings confirm the increasing complexity of the three technologies. Nevertheless, the technology seemed to mainly impact aging people performances: They needed more assistance with the mobile phone than with the fixed phone, and with the tablet computer than with the two others. They also produced more errors with the tablet than with the cellphone, and with the cellphone than with the fixed phone. By comparison, younger participants only produced more errors when using the tablet computer. Moreover, there was a significant difference in the number and the type of human assistance provided: Aging people needed more help, and from higher level, to correct themselves and to learn to execute the task, especially for the most recent technologies. Despite this, all participants succeeded to use the three technologies, even when they had never had before the opportunity to use a computer tablet, confirming its potential simplicity of use [8, 9]. Nonetheless, the link between number of errors and cues with the experience of use deserves further study. Indeed, if 44 % of the younger participants had a tablet at home, they were only 13.6 % among the elderly. And even if the latter were 90.9 % to have a mobile phone, many of them pointed out that the model of the experiment was different from their own. Then, aging people could have more difficulties to adapt to a new technology, and not knowing the technology may increase the difficulty to anticipate the next step to execute. The helpfulness of the hierarchical assistance model seems also to be confirmed. However, more research are needed to confirm if it is more useful to start with general verbal cues in usual situations (increasing cues), while with unusual technologies or for new learning, it may be better to first propose a higher level of help (decreasing cues).

We did not notice any difference between groups for self-corrections; nonetheless, it is quite interesting that aging respondents produced more errors while using more control strategies. Furthermore, they seemed less confident, asking more frequently for help or seeking confirmation. The findings suggest that the main difficulty in the use of communication technologies concerns the decline of efficiency of control strategies and also support the recommendations of Berner [12] concerning the necessity to restore the confidence of the person. Aging people should thus be better assisted in a strategic way, using reinsurance and specific cueing while using the technology.

We acknowledge several limitations to this study. First the sample size was quite small therefore generalizations of the findings are limited. Secondly, we did not explore the inter-rater reliability to verify the objectivity of our analysis grid. Some others variables need also to be explored like, for example, the link with neurocognitive measures or with the frequency of use of each technology. Thus, more research is needed to confirm our results and to advance in the understanding of the data compiled. Nevertheless, favoring access to new information and communication technologies for the elderly give them the opportunity to be more involved in society and contribute to healthy aging. Training has a major role to limit the risk of foreclosure. Finally, the difficulties observed in aging people living at home alone indicate that the combination of a specific observation grid to analyze standardized daily living tasks may be especially sensitive to early neurocognitive disorders.

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References

1. World Health Organization (Ed.) Global Health and Ageing. World Health Organization (2011)
2. Veber, O., Morel, A.L.: Société et vieillissement. Rapport du groupe 1. Inspection générale des affaires sociales: (2011). http://www.ladocumentationfrancaise.fr/var/storage/rapports-publics/114000332/0000.pdf
3. Pigot, H., Giroux, S., Moktari, M.: La gérontechnologie, support au choix des personnes âgées. Premier Congrès de la Société Française des Technologies pour l'Autonomie et de Gérontechnologie (2009)
4. Mitzner, T.L., Boron, J.B., Fausset, C.B., Adams, A.E., Charness, N., Czaja, S.J., et al.: Older adults talk technology: technology usage and attitudes. Comput. Hum. Behav. **26**, 1710–1721 (2010)
5. Nygård, L., Starkhammar, S.: Telephone use among noninstitutionalized persons with dementia living alone: mapping out difficulties and response strategies. Scan. J. Caring Sci. **17**, 239–249 (2003)
6. Nygård, L., Pantzar, M., Uppgard, B., Kottorp, A.: Detection of disability in older adults with MCI or Alzheimer's disease through assessment of perceived difficulty in using everyday technology. Aging Mental Health (2011). doi:10.1080/13607863.2011.605055
7. Russell, H.: Later life ICT learners ageing well. Int. J. Ageing Later Life **6**(2), 103–127 (2011)
8. Findlater, L., Froehlich, J.E., Fattal, K., Wobbrock, J.O., Dastyar, T.: Age-related differences in performance with touchscreens compared to traditional mouse input. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, pp. 343–346. ACM (2013)
9. Werner, F., Werner, K., Oberzaucher, J.: Tablets for seniors – an evaluation of a current model (iPad). In: Wichert, R., Eberhardt, B. (eds.) Ambient Assisted Living. ATSC, vol. 2, pp. 177–184. Springer, Heidelberg (2012)
10. Alm, N., Dye, R., Gowans, G., Campbell, J., Astell, A.J., Ellis, M.: A communication support system for older people with dementia. IEEE Computer society, Washington (2007)
11. Heart, T., Kalderon, E.: Older adults: are they ready to adopt health-related ICT? Int. J. Med. Informatics **82**(11), e209–e231 (2013)
12. Berner, J.: Psychosocial, Socio-Demographic and Health Determinants in Information Communication Technology Use by Older-Adults (Thèse de doctorat). Blekinge Institute of Technology, Suède (2014)

13. Van der Linden, A.C.J.: Démence de type Alzheimer et évaluation des activités de la vie quotidienne. In: Dans, A.C., Van der Linden, J., Aubin, G., Gall, D.L., Van der Linden, M. (dir.) Neuropsychologie de la vie quotidienne, pp. 41–105. Marseille, Solal, France (2008)
14. Suchy, Y., Kraybill, M.L., Franchow, E.: Instrumental activities of daily living among community-dwelling older adults: discrepancies between self-report and performance are mediated by cognitive reserve. J. Clin. Exp. Neuropsychol. **33**(1), 92–100 (2011)
15. Zanetti, O., Frisoni, G.N., Rozzini, L., Bianchetti, A., Trabucchi, M.: Validity of direct assessment of functional status as a tool for measuring Alzheimer's disease severity. Age Ageing **27**, 615–622 (1998)
16. Sikkes, S.A.M., de Lange-de Klerk, E.S.M., Pijnenburg, Y.A.L., Scheltens, P., Uitdehaag, B.M.J.: A systematic review of instrumental activities of daily living scales in dementia: room for improvement. J. Neurol. Neurosurg. Psychiatry **80**, 7–12 (2009)
17. Schwartz, M.F., Buxbaum, L.J., Montgomery, M.W., Fitzpatrick-DeSalme, E., Hart, T., Ferraro, M., Coslett, H.B.: Naturalistic action production following right hemisphere stroke. Neuropsychologia **37**(1), 51–66 (1999)
18. Schwartz, M.F., Montgomery, M.W., Buxbaum, L.J., Lee, S.S., Carew, T.G., Coslett, H.B., Mayer, N.: Naturalistic action impairment in closed head injury. Neuropsychol. **12**(1), 13–28 (1998)
19. Schwartz, M.F., Montgomery, M.W., Fitzpatrick-desalme, E.J., Ochipa, C., Coslett, H.B., Mayer, N.H.: Analysis of a disorder of everyday action. Cogn. Neuropsychol. **12**(8), 863–892 (1995). doi:10.1080/02643299508251406
20. Cooper, R.P., Schwartz, M.F., Yule, P., Shallice, T.: The simulation of action disorganisation in complex activities of daily living. Cogn. Neuropsych **22**(8), 959–1004 (2005). doi:10.1080/02643290442000419
21. Giovannetti, T., Libon, D.J., Buxbaum, L., Schwartz, M.F.: Naturalistic action impairments in dementia. Neuropsychologia **40**, 1220–1232 (2002)
22. Anselme, P., Poncelet, M., Bouwens, S., Knips, S., Lekeu, F., Olivier, C., Majerus, S.: Profinteg: a tool for real-life assessment of activities of daily living in patients with cognitive impairment. Psychologica Belgia **53**(1), 3–22 (2013)
23. Seligman, S.C., Giovannetti, T., Sestito, J., Libon, D.J.: A new approach to the characterization of subtle errors in everyday action: implications for mild cognitive impairment. Clin Neuropsychol. **28**(1), 97–115 (2014)
24. Giovannetti, T., Schwartz, M.F., Buxbaum, L.J.: The coffee challenge: a new method for the study of everyday action errors. J. Clin. Exp. Neuropsychol. **29**(7), 690–705 (2007). doi:10.1080/13803390600932286
25. Bettcher, B.M., Giovannetti, T., Libon, D.J., Eppig, J., Wambach, D., Klobusicky, E.: Improving everyday error detection, one picture at a time: a performance-based study of everyday task training. Neuropsychol. **25**(6), 771–783 (2011). doi:10.1037/a0024107
26. Neistadt, M.E.: A meal preparation treatment protocol for adults with brain injury. Am. J. Occup. Ther. **48**(5), 431–438 (1994)
27. Wojtasik, V., Olivier, C., Lekeu, F., Quittre, A., Adam, S., Salmon, S.: A grid for a precise analysis of daily activities. Neuropsychol. Rehabil. **20**(1), 120–136 (2010)
28. Folstein, M.F., Folstein, S.E., McHugh, P.R.: Mini-mental state. a practical method for grading the cognitive state of patients for the clinician. J. Psychiatr. Res. **12**, 189–198 (1975)
29. Hugonot-Diener, L.: Mini-Mental-Status de Folstein (MMS) version GRECO consensuelle. In: Hugonot-Diener, D.L., Barbeau, E., Michel, B.F., Thomas-Antérion, C., Robert, P. (dir.) GRÉMOIRE: tests et échelles de la maladie d'Alzheimer et des syndromes apparentés, pp. 65–69. Marseille, Solal, France (2008)

30. Fuhrer, R., Rouillon, F.: La version française de l'échelle CES-D (Center for Epidemiologic Studies-Depression Scale): Description et traduction de l'échelle d'autoévaluation. Psychiatrie et Psychobiologie **4**, 163–166 (1989)
31. Deltour, J.J., Echelle de vocabulaire Mill Hill de Raven, J.C.: Adaptation française et normes comparées du Mill Hill et du Standard Progressive Matrices (PM38). Manuel et Annexes. Braine le Château, Belgique: Application des Techniques Modernes (1993)
32. Diehl, M., Marsiske, M., Horgas, A.L.: The revised observed tesks of daily living: a performance-based assessment of everyday problem solving in order adults. J. Appl. Gerontol. **24**(3), 211–230 (2005)