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Mobile health for older adult patients: Using an aging barriers framework to classify usability problems

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ABSTRACT

Background: With populations aging, digital health tools and mobile health applications (mHealth) are becoming more common to assist older people in independent living and self-management of (chronic) illnesses. These mHealth services can be beneficial to older patients, provided that they are adjusted to their needs and characteristics, as the current mHealth landscape lacks user-friendly services for this target group. Understanding of intrinsic aging barriers, which cause and impact usability problems older patients encounter, is needed to achieve this.

Objectives: This study set out to assess usability problems older patients encounter in two mHealth apps and aims to show the value of MOLD-US, a recent aging barriers framework, as a classification tool to identify the intrinsic cause of these problems.

Method: A case-study design, with in-depth analysis of usability issues older adult patients' experience. Data on usability issues were collected using the Think Aloud Protocol for two mHealth apps. The MOLD-US framework and Nielsen's severity rating were used to classify identified issues and their potential impact.

Results: In total 28 high severe usability issues of the mHealth apps were identified. Core natures of most issues were related to motivational and cognitive barriers of older adults. Participants had difficulties in understanding the navigation structure of the apps. Important text, buttons and icon elements were overseen.

Conclusion: Current knowledge on creating interfaces for older target groups is not well applied within the assessed mHealth designs. Specifically, design guidelines should address older adults' diminishing cognition skills, physical ability and motivational barriers. By classifying usability problems with MOLD-US, insights on these barriers can be enhanced to adequately address these issues in new designs. In addition, we propose that future research focuses on investigating suitable usability evaluation methods adapted to older patients' characteristics to ultimately be able to gain unbiased sight on usability issues older patients may experience while interacting with technology.

1. Introduction

With populations aging, digital health tools and mobile health applications (mHealth) are becoming more common to assist older people in independent living and self-management of (chronic) illnesses. These mHealth services can be beneficial to older patients in supporting their health as well as to the healthcare system in controlling healthcare costs, provided that they are accepted and used by their target group. Evidence suggests that one of the most important factors for acceptance of technology by older people is 'usability', the ease of use of the user interface [1]. Yet, according to the European Union (EU) commission's 2012–2020 eHealth Action Plan [2], there is a lack of user-friendly tools and services within the current mHealth landscape and especially older people experience usability problems in mHealth use [3,4].

This is of particular concern within the context of a growing population of older adults, aged 50 +, and specifically for the subset of seniors within this target group, aged 65 + . Digital tools for (senior) older adults may for example provide medication assistance by prompting alerts, self-care advice for diabetes patients, assist heart failure patients in monitoring their blood pressure, promote hospital

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appointment attendance as well as identify and alleviate fall risk factors [5–8]. To gain health support benefits from these tools, older adults need to interact with a vast set of functionalities, a smart device or even a combination of various connected devices. A key issue is thus the complexity of mHealth tools compared to eHealth tools such as a health website, which are more informative of nature. Hence, there is a need to attune the interface design of interactive mHealth services to older patients' needs and characteristics.

Insights into the cause and impact of usability problems these older patients encounter is essential to guide these (re)design efforts. The International Organization for Standardization (ISO) standard and Food and Drug Administration (FDA) regulations state that usability testing with end-users is the norm [9,10]. End-user usability testing sheds light on how a technology communicates specifically with its intended users and identifies which aspects of the user interface are not interacting with the target group as anticipated. The identified flaws in such tests with older adults, including their severity and effects, may be influenced by age related functional decline and disease complexities, occurring from the age of approximately 50 years and onwards, of the older patient target group. By means of a scoping review, we previously investigated aging characteristics of older adults possibly influencing mHealth usability [11]. We identified cognitive, motivational, physical ability and perception barriers and complexities of medical conditions related to these barriers, visualized in the MOLD-US framework, that may impact mHealth usability experienced by older adults [11]. In current usability tests with older adults, aging characteristics and disease complexities are no specific aspect of data analysis, due to a lack of aging barriers frameworks to in relation to mHealth usability; MOLD-US provides the first mHealth aging barriers framework on this matter.

It is necessary to consider these aging characteristics and disease complexities in assessing usability issues of mHealth for older patients, since they provide understanding of the intrinsic cause and impact of usability problems older patients encounter. This study performed usability evaluations of two mHealth apps, both targeted at older people. By analyzing and classifying the usability test results by means of MOLD-US, we aim to demonstrate its value in the data analysis of these mHealth studies. It further reveals which intrinsic causes underly older patients' usability problems they encounter while using mHealth.

2. Methods

2.1. Case study apps and their designs

A case-study approach was chosen to provide detailed illustrations of various interaction issues older adults can encounter in using mHealth. We investigated these interaction issues in two different case studies; an app for older adults facilitating their hospital appointment attendance (App 1) and a self-monitoring app for chronically ill older patients (App 2). Appendix A describes both apps and Appendix B presents a flow chart of the study designs attuned to both apps. Figs. 1 and 2 show screenshots of respectively App 1 and App 2; these were the main screens that were assessed on usability.

2.2. Identification of usability issues

The most prominent *user-based* method, the Think Aloud (TA), was used to gain sight on the usability issues [12,13]. The TA was executed conform the three stages of Nielsen [14]. The tasks, in Table 1, included sets of cognitive tasks and navigation and information search tasks. These tasks were designed by first (GAW) and fourth (LDP) authors, both usability experts and experienced in designing and performing Think Aloud studies with seniors. GAW and LDP identified the main and health-related functionalities of the apps. Subsequently they developed tasks based on these functionalities that were typical for how people might actually use the apps.

2.3. Population and TA sessions

Primary inclusion criteria of all TA participants were: (1) age 50 or above (2) the ability to read and speak Dutch language adequately. Additional inclusion criteria for App 2 were: (3) Heart Failure patient or (4) Chronic Obstructive Pulmonary Disease (COPD) patient. Participants for the TA of App 1 were recruited within the network of the usability evaluators and by contacting and visiting elderly homes of senior older adults. Participants for App 2 were recruited during the installation of the app at the patient's home. The TA sessions, performed by junior usability experts were videotaped. These evaluators

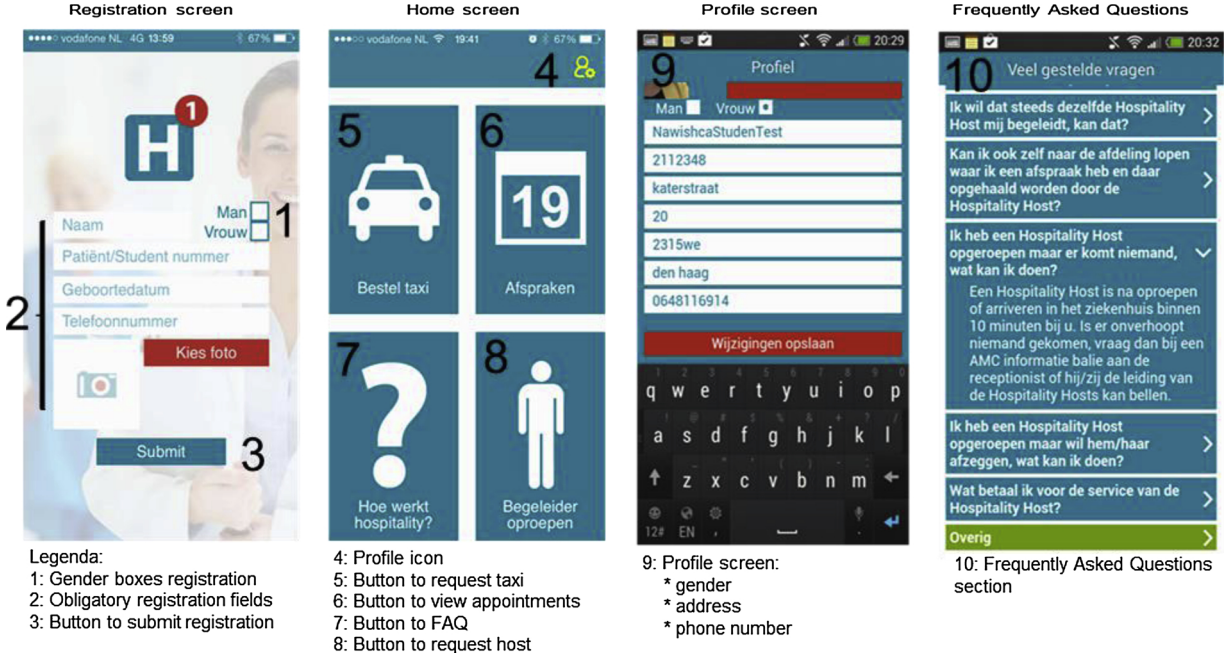

Fig. 1. Screenshots of main screens of App 1.

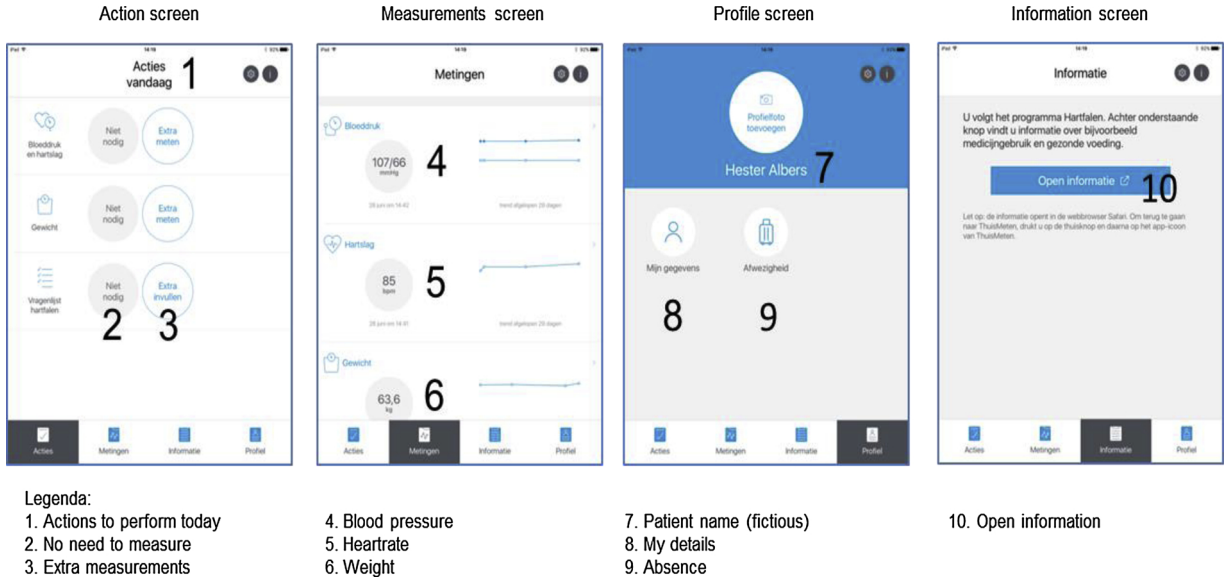

Fig. 2. Screenshots of main screens of App 2.

Table 1
Tasks of the Think Aloud evaluations of App 1 and App 2.

	App 1	App 2
Task 1	Register at the app	Open the app
Task 2	Change postal code of home address after registering	Measure blood pressure levels and send to healthcare professional
Task 3	Find out how to change a scheduled appointment to another date	Measure weight and send to healthcare professional
Task 4	When requested in hospital guidance, find out what to do when the guide is not there	Complete and send health questionnaire
Task 5	Find out if you can use the app if you are visiting the hospital with a family member	Show how many points you had on the previous questionnaire
Task 6	–	Find out how many minutes you should exercise per day
Task 7	–	Register that you will be absent from 10 - 12 October
Task 8	–	Check whether you have messages or missed measurements
Task 9	–	Find out if you can change your measurements' day as a patient

Table 2
Demographics of the participants of the TA.

		App 1	App 2 Heart Failure	COPD
Gender	Male	5	3	4
	Female	8	2	1
Age (mean)		–	66y	67y
Age cluster	50-64y	9	–	–
	65-80y	2	–	–
	80 + y	2	–	–
Experience in using smartphone / tablet	Unexperienced	8	3	1
	Reasonably experienced	0	1	3
	Experienced	5	1	0
	Very experienced	0	0	1
Use of visual aid	Yes (reading glasses, contact lens, etc.)	–	4	5
	No	–	1	0
State of hearing	Good	–	4	3
	Reasonable	–	0	1
	Bad (usage of hearing device)	–	1	1
6CIT score (mean)		–	2.8	1.2

received two weeks of intensive training on performing usability evaluations, instructed by authors GAW and LDP. The participants received instructions on the tasks to perform and first performed a simple practice task, not related to the apps, to get acquainted with the TA method. To assure accurateness of results, authors GAW and LDP validated the results of the evaluations performed by the junior experts by verifying the issue and its severity level.

2.4. Data analysis

Data for the performance measures was extracted from the videos and field notes. Practice task data was excluded from the data analysis. The encountered usability issues were clustered amongst the predefined tasks. Then, issues were prioritized by means of a severity rating from 0 to 4 according to Nielsen's classification of severity [15]. Of the issues with severity rating 3 or 4, authors GAW and LDP independently classified issues by means of the aging barrier aspects of the MOLD-US framework and compared results afterwards. Usability issues were classified by determining where in the app the issue occurred and at which phase of the task, i.e. before even performing the task, during the interaction or in interpreting information after interaction, in combination with older adults' verbal description of the issue they encountered. When any disagreement about the classification occurred, this was noted to measure disagreement frequency. Authors then discussed the usability issue and the classification until 100% agreement was reached.

3. Results

Table 2 shows participants' demographics. Table 3 shows the TA performance measures. Table 4 shows the identified usability issues with severity 3 and 4 (n = 28). These issues were classified by means of the MOLD-US framework (kappa = 0.74); most occurring aging barriers were motivational (n = 14) and cognitive (n = 7).

Table 3
Completion rate per task and average time on task per age cluster of the TA.

Task	App 1	Completion rate Age 50-64y	AVG time on task Age 50-64y	Completion rate Age 65+	AVG time on task Age 65+	App 2	Comple-tion rate	AVG time on task
1	Register	78%	4:45	n.a.	n.a.	Open app	100%	0:29
2	Change postal code	33%	5:52	25%	2:22	Measure and send blood pressure	80%	6:39
3	Reschedule appointment	100%	2:01	75%	26	Measure and send weight	100%	2:46
4	Guide not there	78%	3:08	50%	1:26	Complete and send questionnaire	90%	2:01
5	Use app to request guide if family member present	78%	4:09	0%	n.a.	Show score points previous questionnaire	60%	1:26
6	–	–	–	–	–	Find info on exercise per day	80%	2:22
7	–	–	–	–	–	Register absence	50%	4:52
8	–	–	–	–	–	Check missed measurements	30%	3:25
9	–	–	–	–	–	Change measurements' day	66,6%	3:03

3.1. Usability issues related to motivational and cognitive barriers

Half of the identified high severity issues were categorized as motivational barriers with highest frequencies of low computer literacy and low trust in a patient's own ability to use the app. Patients for example did not know how to return to the app (1 and 2) when they had visited a website/browser.

Cognitive barriers were the second largest category of intrinsic aging barriers negatively influencing usability of the apps. Twenty percent and 31% of the issues of App 1 and App 2 were categorized as cognitive issues respectively. Users found the navigation hierarchy of both apps unclear and did not know how to return to previously shown information in the app, which was categorized as a decline in 'working memory' as intrinsic barrier to this issue. For App 2, users experienced issues in deciding where to find information and how to perform interactions if these were not part of the app's main functionalities. Although participants had a good score on the six item cognitive impairment test (6CIT), they still experienced issues related to a cognitive overload.

3.2. Usability issues related to perception and physical ability barriers

In both apps, patients experienced issues that were categorized at perception level as an intrinsic aging barrier. Users for example oversaw important icons or feedback messages and had difficulties with reading the small font texts in both apps. Of the participants 90% used a visual aid such as glasses during the testing of App 2, but nonetheless experienced usability issues related to perception barriers. Patients only experienced issues categorized at physical ability barriers with App 2; users had difficulties with selecting the scroll bar and clicking at small interaction features.

4. Discussion

In two case studies in which Think Aloud usability evaluations were performed with older adults, we respectively revealed 15 and 13 high severe usability issues of mHealth App 1 and App 2. We applied the MOLD-US framework to classify the usability issues revealed in these case studies based on impediments intrinsic to these issues. Classification via MOLD-US revealed that motivational and cognitive barriers of the older adult users provoked most usability issues in the case studies' apps. Perception and physical abilities of these adults further impeded usability in the studied apps. The case studies showed that MOLD-US allows for improved analysis of results in systematic usability evaluations of mHealth aimed at older adults.

4.1. Perception, cognition and physical ability barriers in relation to design

These findings have important implications for developing mHealth for an aging population. Prior studies noting the importance of specific user interface designs for older people state that use of small targets and characters should be avoided [16]. Likewise the importance of using a proper visual display with objects, such as buttons, that older adults can distinguish from other visual display features is emphasized [16]. The results of this study further support the notion that user-interface design elements such as font size and buttons should be adjusted to the older adult user population. This study additionally points out that existing knowledge on usability heuristics focused on older adults usage of mHealth tools is not yet applied in these services. Regarding cognitive barriers, recent design guidelines for mobile interfaces acknowledge the relevance of cognitive skills in interacting with mobile services and state that cognitive load should be minimized, i.e. by a clear navigational structure and aligning an interface with expectations of older adults [16–18]. Our results further confirm the association between degenerating cognitive skills due to aging and occurring usability issues due to a complexity in functionalities and navigation of the apps.

Table 4
Encountered usability issues (severity 3 or 4) of App 1 and App 2 - categorized by MOLD-US.

MOLD-US category	MOLD-US sub cat.	Usability issue (task)	Sev.	Usability issue (task)	Sev.	Related to	Impact
	Cause	App 1		App 2			
Motivation	Trust in own ability	Users do not know where to change their postal code and do not expect that this can be done under profile details. *(Change postal code)*	3	Blood pressure is automatically sent via Bluetooth from the blood pressure monitor to the app. If the bluetooth connection fails (i.e. Bluetooth button is switched off),no feedback message is given in the app to the user. *(Measure and send blood pressure)*	3	Novice mHealth / medical device users	*App 1:* Possibility for incorrect address details, problem for taxi service. *App 2.* If user repeatedly fails to get measurements on the app, user gives up. Healthcare provider will call to ask what went wrong, that makes user nervous.
		Users do not understand app's functionalities due to a lack of instructions on goal and use of the app. *(Use app with family member)*	4			Complexity of functionalities/ navigation - not attuned to older mHealth older users	Insecurity, leading to non-exploration and rejection.
		In interaction with the apps functionalities users mention the need for usage support. *(Overall issue)*	3			Complexity of functionalities/ navigation - not attuned to older mHealth older users	Insecurity, leading to non-exploration and rejection.
	Computer literacy	'Submit' button for completing registration is not understood by user. *(Register at app)*	3	User does not understand the feedback from the blood pressure monitor (blinking lights) in relation to the text feedback in the app on performed measurements. *(Measure and send blood pressure)*	3	Novice mHealth / medical device users	*App 1:* Uncompleted registration. *App 2:* It is unclear to user if measurements are performed correctly. User tries to perform measurements again, until feedback in the app says blood pressure

							measurements are received.
		User does not know how to go back from 'help' function. *(Change postal code)*	4	User does not know how to recover from mistake (so uses home button of iPad). *(Show score points previous questionnaire)*	3	Complexity of functionalities/ navigation - not attuned to older mHealth older users	Insecurity, leading to non-exploration and rejection.
		User reached website and does not know how return to app. *(Change postal code)*	3	User reached web browser and does not know how return to app. *(Register absence)*	3	Novice mHealth / medical device users	App 1 & App 2: User does not return to using the app.
		Profile icon not understood by user. *(Change postal code)*	4			Novice mHealth / medical device users	Functionalities at profile not used, possibility for incorrect address details, problem for taxi service.
		Users mention the need for support on general mHealth use when unacquainted with mHealth technology. *(Overall issue)*	3			Novice mHealth / medical device users	Insecurity, leading to non-exploration and rejection.
		Users do not recognize the function of buttons due to unclear button design in the app. *(Overall issue)*	4			Novice mHealth / medical device users	Users do not click on buttons, information and actions one level after relevant buttons are not reached and thus not used.
	Efficiency in seeing benefits	Users mention the need for explaining the apps functionalities in the app. *(Overall issue)*	4			Content not attuned to end-user	Insecurity, leading to non-exploration and rejection.
Cognition	Working memory	Unclear hierarchy in app, unknown to user how to return to the previous screen (android specific, no back function on screen, only physical unmarked button on phone). *(Reschedule appointment)*	3	Unknown to user which button to click to view previous measurement. *(Show score points previous questionnaire)*	3	Complexity of functionalities/ navigation - not attuned to older mHealth older users.	Insecurity, leading to non-exploration and rejection.

	Dynamic / selective attention	Information overload in FAQ, questions not ordered, user unable to find answer quickly. *(Reschedule appointment)*	3			Content not attuned to end-user	Relevant information in the app cannot be found by user. Users has to find another solution to obtain information.
	Semantic fluency	English term 'hospitality host' not understood by user *(Hospital guidance)*	3			Content not attuned to end-user	Insecurity, leading to non-exploration and rejection.
	Reasoning			User does not know where to go to receive information about healthy behavior. *(Find info on exercise per day)*	3	Complexity of functionalities/ navigation - not attuned to older mHealth older users	Relevant information in the app cannot be found by user. User has to find another solution to obtain information.
				User does not know which actions to take to register absence and send this to healthcare professional. *(Register absence)*	3	Complexity of functionalities/ navigation - not attuned to older mHealth older users	Not registering absence due to missing data. User subsequently contacts health provider by phone.
				Start date and end date should be registered before clicking 'add absence'. *(Register absence)*	3	Complexity of functionalities/ navigation - not attuned to older mHealth older users	Not registering absence due to missing data. User subsequently contacts health provider by phone.
Perception	Visual acuity	Profile icon is overseen by user due to its small size	3	Button 'back to measurements' is too small and overseen by user when information screen is opened. *(Show score points previous questionnaire)*	3	UI Design not attuned to end-user	App 1: Functionalities at profile not used, possibility for incorrect address details, problem for taxi service. App 2: Insecurity, leading to non-exploration and rejection.

				Message 'data not received' is too small and overseen by user. (Task: Measure and send blood pressure)	4	UI Design not attuned to end-user	If user repeatedly fails to get measurements on the app, user gives up. Healthcare provider will call to ask what went wrong, which makes user nervous.
		User cannot read text in app (too small) *(Overall issue)*	3	Text of frequently asked questions are too small to read for user. *(Change day of measurement)*	3	UI Design not attuned to end-user	Relevant information in the app cannot be found by user. User has to find another solution to obtain information.
Physical abilities	Hand-eye coordination			Scroll bar *absence* is difficult to use for user. *(Register absence)*	3	UI Design not attuned to end-user	Not registering absence. User subsequently contacts health provider by phone.
				Dates are too small for user to click on in webapp for filling in absence. *(Register absence)*	3	UI Design not attuned to end-user	Not registering absence. User subsequently contacts health provider by phone.

The analysis of usability issues in our case studies by means of MOLD-US provides us with understanding of these prominent barriers hampering older adults' usage of the apps. However, MOLD-US in its present form does not provide recommendations on (re)designing apps for older patients based on usability issues encountered. For example, while physical and perceptual problems may be relatively easy to be corrected with existing knowledge on how to design for older adults [16], the functional and conceptual issues are more difficult to tackle. A possible explanation for this might be that many young and middle-aged designers may not be aware of what degenerating cognitive skills of older adults entail, especially not of the seniors. Hence, designers create (unintentionally issue prone) mHealth functionalities and interfaces based on their own assumptions of what older adults can comprehend, as in our case studies. Within this context, Tang et al. [19], showed that senior mobile phone users, even after more than one year experience, still had misconceptions of basic operations and functions. These older users still faced complex problems in terms of understanding how mobile services are structured. Design of mHealth apps could therefore further profit from looking at mental models that older adults have of how something should work, based on their experiences in the real world. Older adults tend to rely on their "rules of thumb" strategies to make decisions and in doing so perform worse on integrating and extracting (new) information [20]. Their rules of thumb might apply to known functions of a smartphone, tablet or an app. Yet, when an app's functionalities are dependent on and/or integrated with unfamiliar device functions and interactions to older adults, they might flounder in its use. Considering the complex hierarchy of a smartphone's or tablet's menu, older adults might permanently experience difficulties in making decisions to navigate through the device's functions, since it places a high demand on remembering a sequence of actions. In the design of our case study apps the functional hierarchical menus and their integration with other device functions, such as internet browsing, alienated the older adult users who were not familiar with these concepts. This hierarchy of these apps could possibly be improved by aligning it with chronological and natural use of the app. Colored information visuals, in our case for example explaining the navigational path and consequences of a decision, could be used as a decision aid tool since these type of visuals have a positive effect on the accuracy of the decisions made by older adults in eHealth tools [20]. We aim to perform more case-studies on usability of mHealth apps as experienced by older patients to expand MOLD-US with these types of recommendations.

4.2. Motivational barriers of older adults in relation to usability and acceptance

Although motivational barriers are acknowledged in acceptance research [8,21–23], they are barely addressed in mobile interface design guidelines and usability research. It is believed that these barriers will diminish over time as middle-aged adults will age and become older adults acquainted with mobile technology [23]. Even though older adults are starting to display interest in using smartphones and tablets for obtaining health information [24], more than 75% indicates they would need help to walk them through the process of learning how to use a new device such as a smartphone or tablet [25]. Based on these insights, we advise to put more emphasis on addressing motivational barriers of older adults within user interface design and guidelines. For example, the Health Information Management and Systems Society guidelines for mHealth state that if a user (intends to) make a mistake, the application helps to avoid it or provides a method to recover from errors gracefully (the system is "forgiving") [18]. In line with Zhang et al. [26], we propose using feedback messages in interfaces and argue that these messages should not only inform users on (the result of) their actions, but should also offer the user options to recover from wrong actions and return to previously retrieved information or actions. Further, a clear (video) instruction on how to use an app should be given when older users register for an app, including an aid to return to this instruction during any point in an app's usage. We additionally advise to involve older populations as co-creators in the requirements analysis and design phases when developing mHealth. Tapping their knowledge

and taking the perspectives of these user groups into account is crucial to create app designs that are easy for them to use.

4.3. Usability testing with older adults

MOLD-US can be of value in improving current approaches to usability engineering. Prominent frameworks used for usability data analysis, such as the User-Action Framework and the Usability Problem Taxonomy [27,28], as well as engineering approaches for evaluation in the design of healthcare information systems, such as explained by Kushniruk [29], may not anticipate the limitations posed by aging barriers in relation to usability evaluations with older adults. Such limitations are nevertheless of importance to take into account, since they may influence study outcomes; MOLD-US can provide an overview of aging barriers that may hamper usability testing. For example, we found that physical as well as cognitive aging barriers and/or medical conditions can cause difficulties with verbally disclosing problems in the interaction with the apps; a high level of trust is needed to have older adults explain such problems to the evaluators, as well as a high level of specific knowledge by the evaluator on the aging characteristics and medical conditions of participants [30]. Secondly, we experienced that the TA method relies heavily on the cognitive capacities of participants, such as communication, attention and speed of comprehension, whereas it is exactly these cognitive capacities that decline with aging. These cognitive skills, especially attention, are deeply solicited by the TA method, hindering people with cognitive limitations like older patients in retaining sufficient attention for using the app under evaluation. An implication of this is the possibility that usability evaluation approaches may need adjustments to prevent reporter bias and become better suited for testing mHealth services with the older adult and chronically ill patient populations. Experts within the field of usability testing are encouraged to undertake future research to improve user-based testing with older adults in dealing with aging barriers that influence usability test results of mHealth applications.

5. Conclusion

The findings of this study showed that use of the MOLD-US framework can reveal usability issues encountered by older adults in using mobile health due to aging barriers that are alike in origin and impact, across different apps or devices used. We conclude that existing knowledge from user interface guidelines on perception, cognitive and physical ability barriers of older adults are currently not applied to the fullest in mobile health interfaces. In addition, motivational barriers of older adults should get more attention in usability research in the field of mobile health. An issue raised by this study is if current end-users usability evaluations, when performed with older participants, and specifically older *patients*, might bias the evaluation results. Especially the Think Aloud method monopolizes attention resources of the older participants, hindering them to fully focus on evaluating the studied technology. Additionally, usability issues provoked by physical ability barriers are not easily identified by the Think Aloud method. To tackle these issues, research into suitable usability evaluation methods adapted to older patients' characteristics is needed. Such methods could ultimately provide unbiased sight on usability issues older patients may experience while interacting with technology.

Authors' contributions

Prof. Dr. MWJ is head of the research line of Human Factors and Usability Studies at the department of Medical Informatics at the Academic Medical Center of Amsterdam, where this research took place. Dr. LDP is an expert in Human Factor methods in Health Informatics. GAW is a PhD student and expert in Human Factor methods for mobile devices. Study conception was created by MWJ and LDP; design was created by MWJ, LDP and GAW. Acquisition of data was guided by LDP, MPS and GAW. Analysis and interpretation of data was performed by LDP and GAW. Drafting of manuscript was performed by GAW, LDP was involved in writing the manuscript from the first version onwards. MWJ was further involved in critical revision of the manuscript.

Conflict of interest

None.

Competing interests

None.

Funding

None.

Summary points

What was already known on the topic:

- Mobile health apps for older adults offer promising solutions to handle health issues associated with the aging society and growth of older adult (chronically ill) patients;
- Cognitive, motivational, physical ability and perception aging barriers of older adults can influence their experienced usability of mobile health negatively.

What this study added to our knowledge:

- Insights into particular usability issues that older adults encounter while using apps aimed at older adult patients;
- How a recent framework of aging barriers, MOLD-US, can add value in classifying identified usability issues of older adults;
- Understanding of origins and effects of older patients' problems in using mobile health as well as usability evaluation methodology in relation to older patients.

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