The Usability of Training Apps for Older Adults

A Heuristic Evaluation

Amrat Kaur and Weiqin Chen

Oslo Metropolitan University, POB 4, St. Olavsplass 0130 Oslo, Norway
{S331369, weiche}@oslomet.no

Abstract: The literature has shown that normal ageing is associated with a decline in sensory, perceptual, motor, and cognitive abilities. Physical activities and cognitive training are considered beneficial for maintaining functional abilities and enabling healthy ageing. Recent years have seen an increase of mobile apps for physical and cognitive exercises. However, few studies have investigated the usability of these apps, particularly for older users, to identify in detail the usability challenges older users face when using these apps. In this paper we present a heuristic evaluation of 10 training apps including five for physical training and five for cognitive training. The results show that all the training apps have usability issues. In order to provide apps with high level of usability for older users, apps designers and developers should take into account usability principles and the characteristics and needs of this user group.

Keywords: Usability, older adults, training apps, heuristic evaluation, physical and cognitive training

1 Background

Ageing is associated with reduced physical and cognitive capacity and a growing risk of disease. Healthy ageing is the process of developing and maintaining the functional ability that enables wellbeing in older age. Several systematic literature reviews and meta-analysis [1-3] have shown the benefits of physical and cognitive training, separately or combined, on healthy ageing.

Mobile technology opens the possibility for providing medical and public health support with mobile devices such as smart phones, tablets, smart watches, and other wireless devices. Mobile health apps for older adults offer promising solutions to manage health issues associated with the aging society and growth of older population. There is an increasing number of smartphone-based apps for physical exercise and cognitive training in the market. Some are developed for younger users and recommended to older adults, while others are developed specially for older adults. Although these apps may be beneficial for the wellbeing of this user group, they can also pose challenges. Poorly designed training apps with low usability could not only discourage older users from using them, but also be potentially harmful for older users.

Previous studies that investigate the usability of training apps for older adults mostly focus on one particular app [4, 5] and use quantitative measurements to evaluate

This is a post-peer-review, pre-copyedit version of a conference proceeding published in HCI International 2022 – Late Breaking Papers: HCI for Health, Well-being, Universal Access and Healthy Aging, HCII 2022, Proceedings, which is part of the Lecture Notes in Computer Science book series (volume 13521). The final authenticated version is available online at DOI: https://doi.org/10.1007/978-3-031-17902-0_30

usability, which often do not provide details of the usability challenges older users face when using the app. The study presented in this paper aims to fill this gap by focusing on the detailed usability challenges posed by cognitive and physical training apps for older users.

2 Related Work

A number of studies have investigated the usability of diverse mHealth apps for older adults, such as apps for medication management [6, 7], diabetes self-management [7], and managing heart failure [8].

Concerning training apps for older adults, Daly and colleagues [4] conducted a pilot study with 20 participants focusing on feasibility, usability and enjoyment of a commercial physical exercise app for older adults living independently in the community. The usability of the app (called "Physitrack") was measured by the System Usability Scale [9]. Pfister and colleagues [5] conducted a mixed methods study on the usability and acceptance of an exercise app (called "Fit") with 20 participants including 10 therapists and 10 adults with mean age 57 years old. In addition to collecting System Usability Scale scores, this study has also measured task completion rate and collected errors and comments made by participants. The data reflected the usability challenges of the app for the participants. Acknowledging the limitation of the study method, the authors of this study commented that combining their study results with other usability methods such as heuristic evaluation or cognitive walkthrough [10] would strengthen their results. A similar study [11] used heuristic evaluation to investigate whether two popular fitness apps Nike+ and RunKeeper were able to accommodate the needs of older users. The study found that small target sizes, insufficient contrast and reduced font sizes are some of the common usability issues that hinder older adults from using these apps. This study concluded that the two fitness apps were not ready to accommodate the needs of older users.

3 Methods

In the study presented in this paper we adopted a heuristic evaluation method to identify usability challenges that training apps pose to older users. A carefully selected group of physical and cognitive training apps (five in each category) for iOS was evaluated based on Jacob Nielsen's 10 usability heuristics[1].

It is difficult to find commercial apps developed specially for older adults. Therefore, we have selected apps that developed mainly for younger users but are recommended to older adults by either health organizations and authorities or ageing-related fora. The five physical exercise apps are: 7 Minute Workout, C25K 5K Trainer, Daily yoga, MapMyWalk, and Yoga studio. The five cognitive training apps are: CogniFit, Elevate, Lumosity, NeuroNation, and Peak. A free version of each app is downloaded from App Store to iPhone with iOS version 12.5.1.

[1] 10 Usability Heuristics for User Interface Design

In each app, a list of representative pages was selected according to a set of criteria such as essential functions and variety of page types. These selected pages are then evaluated using the usability heuristics. A rating scale is used in the evaluation: 0-not applicable or cannot be evaluated, 1-not comply, 2-partially comply, 3-comply. Along with each rating, a description is provided to explain the rating and screenshots are taken to support the description and rating. In cases of unclear rating, both researchers have discussed and come to an agreement.

4 A Brief Introduction of Selected Apps and Pages

4.1 Cognitive Training Apps

All the cognitive training apps offers a variety of features related to brain training activities. Some of the features can only be accessed in the paid version or after the user has carried out a pre-defined number of training activities. The training in cognitive apps is presented as games.

CogniFit (Version 4.2.12). The interface of CogniFit includes five main pages: 1) gives information on today's games and training sessions, 2) shows overview of results, 3) shows statistics and next goals, 4) shows all games, and 5) shows profile and settings. Users are allowed to play 4 to 40 games every day.

Elevate (Version 5.40.0). The interface of Elevate has five main pages: 1) gives information on today's games, 2) shows statistics of results from playing games, 3) shows overall games and statistics, 4) shows notifications, and 5) gives information about achieved goals and settings. Users are allowed to play 3 games every day.

Lumosity (Version 9.84). The interface of Lumosity contains five main pages: 1) gives information on today's game, 2) shows all games, 3) shows statistics and training history, 4) provides insight into game progress reports, and 5) shows settings. Users are allowed to play 3 games every day.

NeuroNation (Version 3.5.76). The interface of NeuroNation has five main pages: 1) gives information on today's games and training sessions, 2) shows extra physical exercises such as stretching which can help with brain training, 3) shows information about Premiums/paid version, 4) shows overview and statistics of results and achievement of goals, and 5) shows settings.

Peak (Version 5.19.0). In the free version, some of the features require users to see a promotional video to get access. The interface of Peak contains four main pages: 1) gives information on today's games, 2) provides an overview of all games, 3) shows the statistics of results from playing the games, and 4) gives information about

achieved goals and settings. Users are allowed to play 2-3 different games once every day and have access to 2-3 new games every day. If users want to play these games again, they must first see a promotional video.

For all five cognitive training apps, the following common features have been selected for evaluation: choosing a game, starting a game, pausing/restarting a game, and quitting a game. In addition, some common pages in each app were evaluated, including the overview page of all games, the main pages for each game where users start game and see information/introduction/statistics about the game, and the pages where users play the games.

4.2 Physical Training Apps

Due to the diversity of the physical training apps, it is difficult to identify common pages in all apps. However, most of the apps have features such as choosing/starting/pausing/quitting a workout/an exercise. These are selected for evaluation. In addition, we have selected some specific pages and features in each app. These are presented in the following sections.

7 Minute Workout (Version 4.4.9). This app contains three main pages: 1) allows users to choose a workout and start training. Settings for the whole app is also included in this page such as music and favorite exercises. For each workout, users can see which exercises are included and the information about these exercises. 2) allows users to make their own workout by choosing and adding different exercises. 3) shows users' progress over time and allows users to register their weights.

The pages selected for evaluation include the first page where users choose workout, start training and the exercise pages. The features evaluated in these pages include choosing an exercise, seeing an overview of exercises in a workout, and getting information about exercises, turning on/off music, starting an exercise, pausing the exercise, going back and forth between exercises, setting music and voice guidance, and going to full screen.

C25K 5K Trainer (Version 5.1.0). This app has one main page. From this page, users can go to settings, turn on/off dark mode, choose workout, and start workout.

The pages selected for evaluation include the page where users choose and start workout and the page where a workout starts. The features evaluated in these pages are: turn on/off dark mode, choose a workout, start a workout, pause a workout, and continue, change music setting and go back and forth between exercises in a workout.

Daily Yoga (Version 7.49.00). This app has five main pages: 1) gives an overview of a training plan, completed workout and favorites. 2) gives an overview of all workouts. 3) only shows for paid users. 4) allows users to communicate with other users and sharing photos and workouts. 5) allows users to edit profiles and change settings.

The pages selected for evaluation include the pages where users choose and start workout and the page when a workout starts. The features evaluated in these pages are: choose a workout, start a workout, pause a workout, quit a workout, turn on/off music, go back and forth between exercises in a workout, change music setting and voice guidance, and go to full screen mode.

MapMyWalk (Version 21.8.0). This app contains five main pages: 1) allows users to explore the app, find friends and see information about their own training. 2) allows users to make challenges with friends and gives an overview of existing challenges. 3) provides users with choices of activities and changing settings. In this page, users can also connect via Bluetooth to other devices that measure pulse, speed, calories, etc. 4) allows users to set up goals and training plans and shows an overview of completed and future goals. 5) shows diverse additional information and features such as profile, setting, privacy, help, friends, goals and workout routines.

The pages selected for evaluation include the pages where users choose and start a workout and change settings related to the workout. The features evaluated in these pages include: choose a workout, start a workout, pause a workout, quit a workout, change setting for Voice Feedback, set up Delay Start Timer, see notifications, get information about upgrade, and connect to other devices via Bluetooth.

Yoga Studio (Version 4.3.45). This app has five main pages: 1) shows downloaded Yoga poses for use without network connection and allows users to change settings. 2) shows all Yoga blocks users can choose from. Users can make their own blocks by combining a set of poses. 3) shows all Yoga poses where users can browse and search. Yoga poses are described with text and image describing the exercise step-by-step. 4) allows users to plan their own training. 5) shows achieved goals and badges.

The pages selected for evaluation include the pages where users choose and see information about Yoga poses and make their own Yoga blocks. The features evaluated in these pages are: search and choose Yoga poses, choose among blocks, and see/add favorites.

5 Result

In this section we will first present an overview of the evaluation results (Table 1 and 2), followed by a more detailed description of the challenges and issues categorized based on the usability heuristics.

As shown in Table 1, all 10 apps were evaluated either Comply or Partially Comply to all heuristics expect for 7 Minute Workout and Yoga Studio. Seven apps had more partial complies than full complies across all heuristics. CogniFit fully complies to only one heuristic, while C25K fully complies to six heuristics. Table 2 shows that all heuristics were found to be either complied or partially complied except for Heuristic 9: Help users recognize, diagnose, and recover from errors. Six heuristics received more partial complies than full complies across all apps. Heuristic 3: User

control and freedom and Heuristic 4: Consistency and standards received one fully comply each, while Heuristic 2: Match between system and the real world received eight fully complies.

Table 1. Evaluation results of all 10 apps (how many heuristics each app complies, partially complies, does not comply and heuristics that are not applicable or cannot be evaluated).

Apps		**Comply**	**Partially comply**	**Not comply**	**Not applicable or cannot be evaluated**
Cognitive	CogniFit	1	9	0	0
	Elevate	4	6	0	0
	Lumosity	4	6	0	0
	NeuroNation	3	7	0	0
	Peak	2	8	0	0
Physical	7 Minute Workout	4	5	0	1
	C25K	6	4	0	0
	Daily Yoga	5	5	0	0
	MapMyWalk	5	5	0	0
	Yoga Studio	4	5	0	1

Table 2. Evaluation results of all 10 training apps categorized by usability heuristics (for each heuristic, how many apps comply, partially comply, do not comply and the heuristic is not applicable or cannot be evaluated).

Usability Heuristics	**Comply**	**Partially comply**	**Not Comply**	**Not applicable or cannot be evaluated**
1. Visibility of system status	2	8	0	
2. Match between system and the real world	8	2	0	
3. User control and freedom	1	9	0	
4. Consistency and standards	1	9	0	
5. Error prevention	2	8	0	
6. Recognition rather than recall	2	8	0	
7. Flexibility and efficiency of use	4	6	0	
8. Aesthetic and minimalist design	7	3	0	
9. Help users recognize, diagnose, and recover from errors	5	3	0	2
10. Help and documentation	6	4	0	

5.1 Evaluation Results Categorized by Heuristics

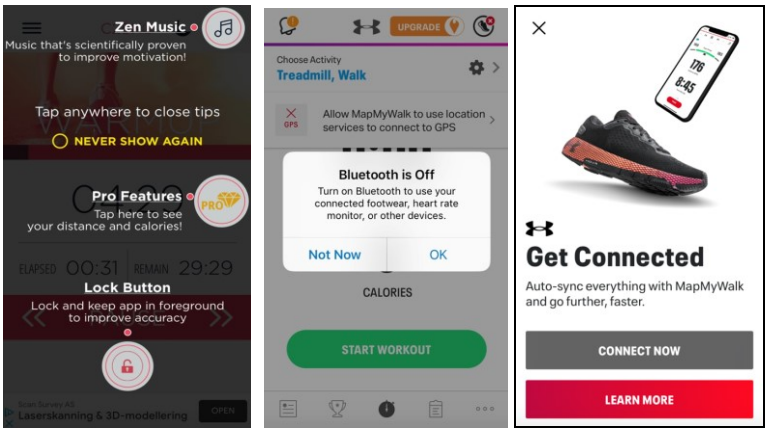
In the following sections we will provide details of the evaluation results of the apps categorized based on the usability heuristics.

Heuristic 1: Visibility of system status. This heuristic concerns keeping users informed by showing system status and feedback in a timely and appropriate manner. Except for NeuroNation and Daily Yoga, we have found system status visibility issues in all the other apps evaluated. For example, in CogniFit and Elevate, warning sounds are missing when a game starts or finishes. In Lumosity, users do not get immediate feedback that it is a locked game when they try to open one. Instead, the main page for the game opens with a button which users must press to unlock with Premium. In Peak users of the free version are required to see a promotional video when they want to play a game again. However, Peak does not inform users that the video is a promotional video. In 7 Minute Workout's full screen mode it is not clear for users where to tap in order to pause a workout. In C25K voice feedback announces workout start/stop, but this voice does not announce pause and resume. A similar issue was also found in MapMyWalk. In Yoga Studio, a user can choose a photo for the Yoga block s/he has created. However, there is no indication (e.g. by using a check box) on which photo the user has chosen.

Heuristic 2: Match between system and the real world. This heuristic concerns using familiar concepts, symbols, and terms and presenting information in natural and logical order to users. Except for CogniFit and Yoga Studio, all the other evaluated apps have satisfied this heuristic. In CogniFit some of the terms such as *inhibition* and *shifting* under Trained Skills in the game introduction may be difficult for users to understand. Yoga Studio provides descriptions of poses. Most of the descriptions are easy to understand, especially with the additional images of the poses. However, some pose descriptions refer to other pose names which users may not be familiar with. It would be helpful if it provides a link to the other pose descriptions or tooltips explaining the pose names.

Heuristic 3: User control and freedom. This heuristic concerns providing users with possibilities for going back, undoing, or canceling their action, thus allowing users to have a feeling of control and freedom and avoid frustration. Except for Yoga Studio, none of the other apps evaluated fully satisfy this heuristic. In CogniFit, users can neither skip over instruction, go back and forth between pages in the introduction, nor have they an option to restart a game. In Elevate, when a user pauses a game, a page shows up with options of *Resume*, *Restart*, *Menu*, and *Game Instructions*. The *Menu* option is in fact the possibility to quit the game and go back to the main menu. But this is not clear to users. In Lumosity, if a user chooses to see the introduction before playing a game, the game starts automatically after the introduction. If the user wants to see the introduction again, s/he must pause the game first, then choose *How to play* in the next page. In NeuroNation, after a user has paused a game, s/he must first quit

the game and start it again since there is no restart option. In Peak, users must see all the steps in the introduction of a game. They are not allowed to go back and forth between steps. In 7 Minute Workout it is not possible to pause the animation showing how to carry out the exercise. A similar issue was found in Daily Yoga where users are not allowed to pause instruction videos. In C25K when users start a workout, the app shows some tips. Users can tap anywhere to close tips. However, if users choose *Never Show Again*, it is not possible to find these tips again (Fig. 1a). In MapMyWalk, when users press the *Shoe* icon (connecting to other devices with Bluetooth), if the Bluetooth is not turned on, a message pops up giving users two options (Fig. 1b). Users can press *OK* to continue with turning on Bluetooth. If users choose *Not Now*, a page shows up anyway asking users to either connecting to Bluetooth or learning more about Bluetooth connection and auto-sync.

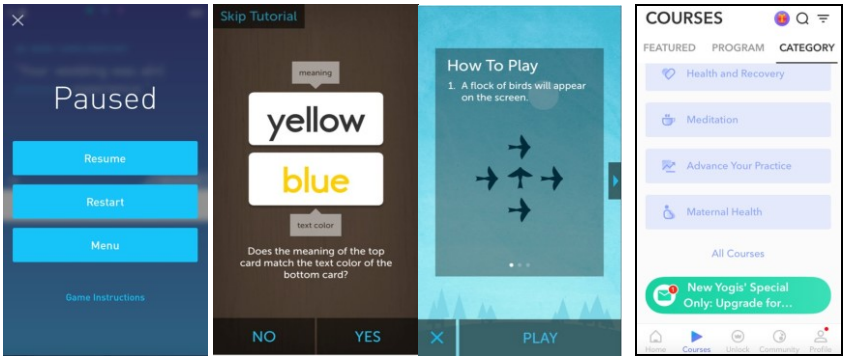


(a) (b)

Fig. 1. Screenshots illustrating a lack of user control and freedom. (a) In C25K it is not possible for users to find the tips if they choose *Never Show Again*. (b) In MapMyWalk *Not Now* does not stop the app from asking users for Bluetooth connection.

Heuristic 4. Consistency and standards. This heuristic concerns maintaining internal and external consistency to improve learnability and reduce cognitive load. In our evaluation, all the apps except for Yoga Studio have consistency issues. In CogniFit, some of the warning sounds are the same for all games (e.g. for starting a game or going to a next level), while other warning sounds (e.g. for a right answer or a wrong answer) are different from game to game. A similar issue was also found in Peak. In C25K the icon that is expected to show the length of workout time does not change when the workout length changes. In Elevate, the *Game Instructions* option has a different design than the other options (Fig. 2a). In Lumosity, instructions can be skipped in two different ways, one using *Skip Tutorial* and the other using a cross icon (Fig. 2b). NeuroNation uses different background colors for different games. However, when a user goes back from a game (with a specific background color) to the main page, the main page's background color becomes the same as the game's

background color. This could be confusing for users if they use color to recognize games. Daily Yoga shows an icon in the upper right corner of a page with all training courses. It could be difficult for users to understand that this icon means sorting and filtering training courses (Fig. 2c). In MapMyWalk, the *Shoe* icon means connecting to other devices via Bluetooth. A Bluetooth icon would be easier to understand for users. 7 Minute Workout uses two different icons in different pages for music setting.



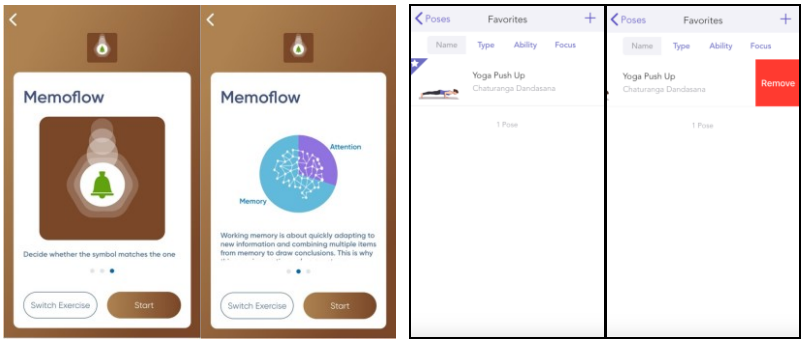
(a) (b) (c)

Fig. 2. Screenshots illustrating issues with consistency and standards. (a) Options have different design in Elevate. (b) Different ways to skip an instruction in Lumosity. (c) Icon for sorting and filtering (upper right corner) in Daily Yoga.

Heuristic 5: Error prevention. This heuristic concerns eliminating error-prone conditions and asking users to confirm before they commit to an action that can cause an error. Except for 7 Minute Workout and C25K, all the other apps have issues in error prevention. Elevate, Lumosity, Peak, and NeuroNation do not require confirmation or inform users about the exercise is not saved when they press the *Quit*/*Exit* exercise button or *Pause* button for going back to the main page. CogniFit informs users that if they exit from a game their progress will not be saved. Users are expected to read this information, because when they click on *Exit*, there is not confirmation. In Lumosity, if a user wishes to see instructions again while s/he is playing a game, the game restarts automatically after the instructions finish and the progress data is not saved. The user is not warned about this beforehand, neither is the user required to confirm the see instructions action. In Daily Yoga, users can delete search history by pressing *Clear* without any confirmation or warning. In MapMyWalk, when users press *Learn More* they are taken to an external website for developers. Users are not informed or warned about the external website, nor are they required to confirm. This could be confusing for users. In Yoga Studio, when users delete a Yoga pose from Favorites or from a Yoga block they are not required to confirm.

Heuristic 6: Recognition rather than recall. This heuristic concerns minimizing users' memory load and reducing the information users have to remember by making elements, actions and options visible and easily recognizable. Except for 7 Minute

Workout and MapMyWalk, challenges with this heuristic were found in all the other apps. In CogniFit, Elevate, Lumosity, NeuroNation, and Peak, users have to remember that they need to first pause the game in order to see instructions. In NeuroNation, users also have to remember to swipe up in order to see more information about a game because there is no indication (e.g. a scroll bar) on the page that the users can swipe up. In C25K, free version users have to remember which functions are only for paid users and which are available in the free version. In Daily Yoga, when users try to search for courses/poses/users no suggestions are given, and users must know exactly what they search. This requires that users know for example the name of courses or poses. In Yoga Studio, users can see a list of blocks or favorites. In order to delete one item from the list, users must remember to swipe from right to left on the item in order to make the *Delete/Remove* button visible.



(a) (b)

Fig. 3. Screenshots illustrating issues with recognition. (a) No visible possibility to scroll down in NeuroNation. (b) No visible *Remove* option in Yoga Studio before swiping.

Heuristic 7: Flexibility and efficiency of use. This heuristic concerns flexibility and efficiency of user actions by providing shortcuts, allowing users to customize and tailoring content and functions for individual users. Daily Yoga, C25K, Elevate, and Lumosity were found to comply to this heuristic. In CogniFit, NeuroNation, and Peak users do not have possibility to go back and forth or choose to see only one specific step in the instructions. In 7 Minute Workout, it is not possible to search. If users wish to find a specific workout, they have to browse through all the workouts. In Yoga Studio, users also need to browse when grouping poses and blocks according to categories. A filtering option will likely make this more efficient. In MapMyWalk, if a user wishes to move some stats from *Not Shown During Workout* to *Shown During Workout* or vice versa, s/he needs to press the icon on the right side, then hold and move the item up or down. There are no other options for users who are not able to perform this drag-and-drop gesture.

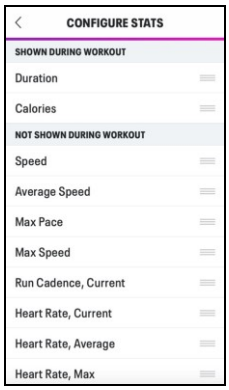
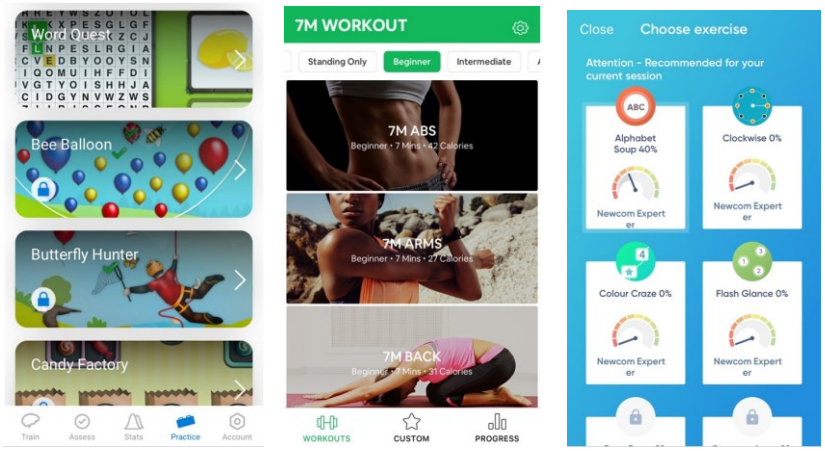


Fig. 4. In MapMyWalk moving item must use drag-and-drop gesture.

Heuristic 8: Aesthetic and minimalist design. This heuristic concerns keeping content and visual design of a user interface focused on the essentials and avoiding distracting users with unnecessary elements. Except for 7 Minute Workout, CogniFit, and NeuroNation, all the other apps satisfy this heuristic. In CogniFit, the backgrounds for the game names are images of the games, which could make the names difficult to read. This also makes the interface seem crowded (Fig. 5a). The same issue is found in 7 Minute Workout where the backgrounds for workouts/exercises are images (Fig. 5b). In NeuroNation, when choosing an exercise, a user can see the progress levels from Newcomer to Expert. The "er" at the end of Newcomer is put in the next line (Fig. 5c) due to issues in the layout design.



(a) (b) (c)

Fig. 5. Screenshots illustrating issues with Aesthetic and minimalist design. (a) Backgrounds for game names in CogniFit. (b) Backgrounds for workout types in 7 Minute Workout. (c) Word breaking in NeuroNation's layout design.

Heuristic 9: Help users recognize, diagnose, and recover from errors. This heuristic concerns communicating error messages to users in a clear and understandable manner and providing guidance to recover from errors. C25K, CogniFit, Elevate, MapMyWalk and NeuroNation satisfy this heuristic. In Daily Yoga, if a user using a free version chooses a PRO-workout (not a free workout) by mistake, instead of informing the user that this is a paid workout, it shows *Try for Free* with *Time limited* in small font size. When the user presses *Try for Free*, a warning pops out telling the user about starting a 7-day free demo to get access to the workout (Fig. 6). Such feedback can be confusing for users. Similar issue was found in Lumosity and Peak when users try to open a locked game (not a free game).

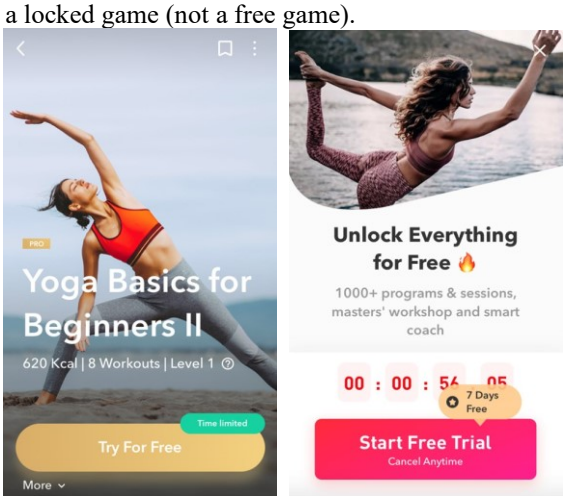


Fig. 6. Pages shown after a free-version user chooses a non-free workout in Daily Yoga.

Heuristic 10: Help and documentation. This heuristic concerns providing easily accessible documentation for users. 7 Minute Workout, C25K, Daily Yoga, Lumosity, MapMyWalk and Yoga Studio satisfy this heuristic. All 10 apps provide some instructions for users in the beginning of a game or workout with diverse level of details from video instructions (e.g. Daily Yoga), step-by-step textual instructions with images (e.g. Yoga Studio), to simple and brief instructions in text form (e.g. C25K). When a user has spent a long time on a task, Elevate provides just-in-time help to guide the user to complete the task. While playing a game, users in Peak can press the *Question Mark* icon to access instructions. In CogniFit, at the beginning of a game, the app provides a step-by-step instruction/simulation on how to play, but the instruction cannot be seen again during the game. If users pause the game and choose to see instructions, the app shows a brief instruction in text. In Elevate, the information about the icon is difficult to find which shows the data for the game are not registered. In NeuroNation, instructions are given to users while users are playing the game and it is not possible to skip the instructions. In Peak, instructions in text bubbles fly in from left and disappear in the right, while animations are shown to users how to play the game. To follow the instructions requires multitasking skills.

5.2 Summary of the Results

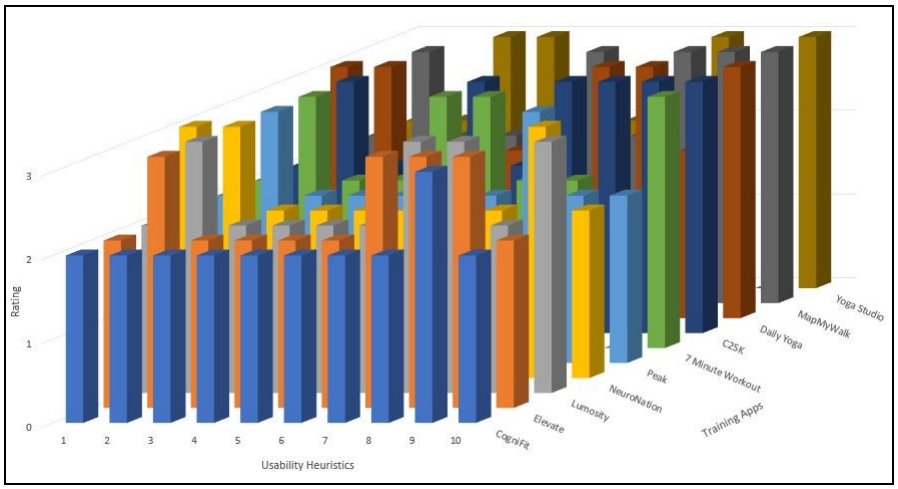


Fig. 7. Overview of evaluation results for all 10 training apps.

Fig. 7 shows the overall rating of all apps and all heuristics. The evaluation has shown many good usability practices in the apps, including showing clearly which pages users are in with colors and text (e.g. 7 Minute Workout, Daily Yoga, CogniFit, Peak) and using warning sounds in combination with text and image as feedback (e.g. C25K, Elevate), using clear and easily understandable languages and familiar images as icons such as moon icon for dark mode, note icon for music settings (e.g. C25K, Daily Yoga, Lumosity, NeuroNation), allowing users to pause/resume/restart games or workouts (C25K, MapMyWalk, Lumosity), and browse, search and group exercises (e.g. Daily Yoga, MapMyWalk, Yoga Studio), consistent use of icons and button layouts (e.g. C25K, Yoga Studio), preventing errors by warnings and confirmations (e.g. C25K, 7 Minute Workout), providing text together with icons so users do not need to remember the meaning of icons (e.g. C25K, 7 Minute Workout, Lumosity, Yoga Studio), providing users with possibilities to change settings, making own training plans and Yoga blocks (e.g. 7 Minute Workout, Yoga Studio), keeping content and visual design focused on essential activities such as choosing and playing games and carrying out exercises (e.g. 7 Minute Workout, Elevate), giving immediate feedback and suggestions when users make mistakes (e.g. C25K, 7 Minute Workout) and providing instructions/help in context right at the moment that the user requires it (e.g 7 Minute Workout, Elevate, Peak).

Despite of the good usability practices, the evaluation has also revealed many design issues that do not satisfy the heuristics. In particular, more than half of the apps were found to have usability issues related to heuristics 1, 3, 4, 5, 6, and 7. Some of the main usability issues include not requiring confirmation or informing about progress data is not saved when a user presses the *Quit* exercise button or *Pause* button for going back to main page (e.g. Lumosity, NeuroNation, Elevate), not allowing

users to pause, go forward or backward when playing the instruction videos or animations (e.g. 7 Minute Workout, Daily Yoga, CogniFit), not showing visible scroll bar when users must remember to swipe to see more information (e.g. NeuroNation), not showing differences between functions that are free and functions that only paid users can access (e.g. C25K), difficult for users to understand and press-and-hold icons to move items up and down (e.g. MapMyWalk). In addition, small font size, small icons, and low color contrast between foreground and background were found in several apps (e.g. Elevate, Lumosity, Yoga Studio).

6 Discussion

The effects of ageing on perceptual, motor and cognitive abilities make it challenging for many older adults to use mobile apps [12]. Some older users find the small target size difficult; others find some gestures challenging to perform. In our study and other previous studies such as [11], small target size and specific gesture such as drag-and-drop are identified as usability challenges. Reduced motor skills also cause more errors when interacting with apps. Older users are often afraid of making mistakes when they use digital technology. It is therefore essential that apps for older users are designed to prevent errors, providing easily understandable error messages, and supporting undo and error recovery (Heuristic 3, 5 and 9). In our study, several apps are found not informing users about possible progress data loss and/or not requiring users to confirm when they try to delete information. Such usability issues will enhance the negative experiences of older users with the apps. The decrease in visual perception includes reduced peripheral vision, color vision, contrast detection and dark adaptation [13]. Therefore, many older users found small font size and low contrast difficult. Our study confirms several other studies [11, 14] that apps do not meet older adults' specific visual requirements. Hearing ability declines to 75% for people between 75 and 79 years of age [13] and they are also become more easily distracted by details or noises. In our study, we have found crowded interfaces in some apps (Heuristic 8). Some apps make use of sounds or voice feedback, but lack of consistency (Heuristic 4). Such usability issues will also increase the cognitive load for older users.

Cognitive decline associated with ageing causes the short-term memory to retain fewer items and the working memory to be less efficient. Older adults also have difficulty maintaining attention on more than one aspect at once [15]. Our study shows that some apps do not have a visible scroll possibility and require users to remember to swipe in order to see the complete information (Heuristic 6). Some apps require users to focus on more than one element such as text bubbles flying in while an animation is playing. Some apps use different icons for the same activity and some non-standard icons are found to be difficult to understand (Heuristic 4).

Our findings have not only confirmed the common usability challenges mobile apps pose for older adults such as small target size, small font size, and low contrast, but also revealed some new challenges and good practices that are related to digital literacy of older adults and their technology acceptance. Older users often feel insecure or unconfident about their own ability to use digital technology[16]. Therefore,

easily understandable languages, error prevention, multimodal feedback, as well as just-in-time help are important in supporting older users to overcome these challenges. For training apps, in particular, timely, clear, and easily accessible instructions are also crucial for older users to accept and make use of the apps, as shown in our findings.

In the past decade, a few mobile app design guidelines and checklists for older adults have been developed (see [17] for an empirical analysis) which cover an increasingly complex set of usability categories and dimensions. Although these guidelines and checklists need further empirical validation, they can be useful resources for developers when developing mobile apps for older adults. Many of the usability challenges we identified in our study are covered by these guidelines and checklists.

7 Conclusion

This paper presents a heuristic evaluation of 10 training apps for older adults. The results have not only confirmed the findings from previous studies, but also revealed challenges and good practices related to older adults' digital literacy and technology acceptance.

Although we did not use the severity scale in the evaluation, we have identified several severe issues in the apps including the lack of confirmation or feedback about losing progress data when users quit or pause an exercise. Future study should further investigate the usability of training apps for older adults by user testing and evaluating apps on different mobile devices such as Android phones, tablets, and smart watches.

Previous studies have demonstrated that older users are increasingly able to use technology to remain independent, promote a heath lifestyle and improve their quality of life. Decrease in cognitive and physical abilities among older adults can have negative impact on their experienced usability of mobile apps. Training apps developers may overlook a major group of users by failing to provide apps with high level of usability. When recommending training apps to older adults that are not designed especially for them, it is also important to consider the usability aspects and the special needs of this user group.

The universal nature of the 10 usability heuristics by Nielsen allows for its wide application in the evaluation of user interfaces. However, the heuristics have not been created specifically for the design of mobile apps for older adults. Recent years have also seen the efforts in developing heuristics to evaluate mobile apps targeted at older users [18] and in developing mHealth evaluation framework and questionnaires, such as the mHealth App Usability Questionnaire (MAUQ) by [19]. The MOLD-US framework by [20] are specially designed to classify usability barriers of mHealth applications for older adults. Such heuristics, framework, and questionnaires could be considered in future evaluation and analysis of training apps for older adults.

8 References

1. Daskalopoulou, C., Stubbs, B., Kralj, C., Koukounari, A., Prince, M., Prina, A.M.: Physical activity and healthy ageing: A systematic review and meta-analysis of longitudinal cohort studies. Ageing Research Reviews 28, 6-17 (2017)
2. Gavelin, H.M., Dong, C., Minkov, R., Bahar-Fuchs, A., Ellis, K.A., Lauten-schlager, N.T., Mellow, M.L., Wade, A.T., Smith, A.E., Finke, C., Krohn, S., Lampit, A.: Combined physical and cognitive training for older adults with and without cognitive impairment: A systematic review and network meta-analysis of randomized controlled trials. Ageing research reviews 66, (2021)
3. Tetlow, A.M., Edwards, J.D.: Systematic Literature Review and Meta-Analysis of Commercially Available Computerized Cognitive Training Among Older Adults. J Cogn Enhanc 559–575 (2017)
4. Daly, R.M., Gianoudis, J., Hall, T., Mundell, N.L., Maddison, R.: Feasibility, usability, and enjoyment of a home-based exercise program delivered via an exercise app for musculoskeletal health in community-dwelling older adults: short-term prospective pilot study. JMIR Mhealth Uhealth 9, (2021)
5. Pfister, P.B., Tobler-Ammann, B., Knols, R.H., de Bruin, E.D., de Bie, R.A.: Usability and Acceptance of an Interactive Tablet-Based Exercise Application: A Mixed Methods Study. Frontiers in Digital Health 2, (2020)
6. Grindrod, K.A., Li, M., Gates, A.: Evaluating user perceptions of mobile medication management applications with older adults: a usability study. JMIR Mhealth Uhealth 2, e11 (2014)
7. Gao, C., Zhou, L., Liu, Z., Wang, H., Bowers, B.: Mobile application for diabetes self-management in China: do they fit for older adults? Int. J. Med. Inform 101, 68-74 (2017)
8. Morey, S.A., Barg-Walkow, L.H., Rogers, W.A.: Managing heart failure on the go: usability issues with MHealth apps for older adults. Hum. Factors Ergon. Soc. Annu. Meet. Proc, vol. 61, pp. 1-5 (2017)
9. Brooke, J.: SUS - A Quick and Dirty Usability Scale. In: Jordan, P.W., Thomas, B., Weermeester, B.A., Mcclelland, A.L. (eds.) Usability Evaluation in Industry. Taylor and Francis, London (1996)
10. Jaspers, M.W.: A comparison of usability methods for testing interactive health technologies: methodological aspects and empirical evidence. Int J Med Inform. 78, 340-353 (2009)
11. Silva, P.A., Holden, K., Nii, A.: Smartphones, Smart Seniors, But Not-So-Smart Apps: A Heuristic Evaluation of Fitness Apps. In: Schmorrow, D.D., Fidopiastis, C.M. (eds.) Foundations of Augmented Cognition. Advancing Human Performance and Decision-Making through Adaptive Systems (AC 2014). Lecture Notes in Computer Science, vol. 8534. Cham, Springer (2014)
12. Czaja, S.J., Boot, W.R., Charness, N., Rogers, W.A.: Designing for older adults: Principles and creative human factors approaches. CRC Press, Boca Raton, FL (2019)
13. Fozard, J.L.: Vision and hearing in aging. In: Birren, J.E., Schaie, K.W. (eds.) Handbook of the Psychology of Aging, pp. 150–170. Academic Press, New York (1990)
14. Wildenbos, G.A., Jaspers, M.W.M., Schijven, M.P., Dusseljee-Peute, L.W.: Mobile health for older adult patients: Using an aging barriers framework to classify usability problems. International Journal of Medical Informatics 124, 68-77 (2019)
15. Craik, F.I.M.: Ageing memory: ageing memories. In: Rabbitt, P. (ed.) Inside Psychology: A Science Over 50 Years, pp. 73-89. Oxford University Press, UK (2009)

16. Vroman, K.G., Arthanat, S., Lysack, C.: “Who over 65 is online?” Older adults’ dispositions toward information communication technology. Computers in Human Behavior 43, 156-166 (2015)
17. Petrovčič, A., Taipale, S., Rogelj, A., Dolničar, V.: Design of Mobile Phones for Older Adults: An Empirical Analysis of Design Guidelines and Checklists for Feature Phones and Smartphones. International Journal of Human-Computer Interaction 34, 251-264 (2018)
18. Silva, P.A., Holden, K., Jordan, P.: Towards a List of Heuristics to Evaluate Smartphone Apps Targeted at Older Adults: A Study with Apps that Aim at Promoting Health and Well-Being. Proceedings of the Annual Hawaii International Conference on System Sciences, pp. 3237-3246 (2015)
19. Zhou, L., Bao, J., Setiawan, A., Saptono, A., Parmanto, B.: The mHealth App Usability Questionnaire (MAUQ): Development and Validation Study. JMIR mHealth and uHealth 7, e11500 (2019)
20. Wildenbos, G.A., Peute, L., Jaspers, M.: Aging barriers influencing mobile health usability for older adults: a literature based framework (MOLD-US). Int. J. Med. Inform. 114, 66-75 (2018)