Smartphones, Smart Seniors, But Not-So-Smart Apps: A Heuristic Evaluation of Fitness Apps

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Abstract. This paper reports on the results of a heuristic evaluation of Nike+ and RunKeeper, two of the most popular health and fitness mobile apps found in both Google Play and the iTunes stores for Android and iOS platforms respectively. Given the potential benefit of practicing physical exercise in living a healthier and longer life, this study aimed at understanding whether or not these apps are ready to accommodate the needs of older adult users. The study concludes that the inspected apps are not ready to accommodate older adults needs. Small target sizes, insufficient contrast and reduced font sizes, are some of the common violations found in the user interfaces; these are also impeditive of the use of the apps by this target user population. It is thus necessary to highlight these issues in order to eliminate the barrier of access to these apps by this population by also encouraging careful observation of design guidelines.

Keywords: Older adults, gamification, health and fitness, heuristics, heuristic evaluation, active aging.

1 Introduction

If one browses Google Play or the iTunes store present-day, one realizes that health and fitness apps are massively downloaded (100,000+). This indicates that these apps are to some extent well received by users. But are they ready to be used by the aging population?

The world's population is getting older [1], but also more active and health conscious. Studies indicate that exercise plays an important role in the improvement and prevention of health conditions [2], [3], [4], saving lives and money in treatment and medicine [5]. Mobile apps are expected to play an increasingly important role in health and well-being [6] and, if they have not yet, these apps will eventually reach older adults, therefore it is important that these apps accommodate the characteristics of this user group. Interestingly enough older adults are also the fastest growing group buying smartphones [7].

In this context, the goal of this study is to identify if currently available smartphone health and fitness apps are ready to be used by older adult users, and if not, what

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barriers to entrance, onboarding and adoption might exist. To improve the understanding of this issue, a heuristic evaluation was performed by three evaluators of two of the most popular and free, health and fitness apps available on both the iOS and Android smartphone platforms: Nike+ and RunKeeper; the outcomes of this heuristic evaluation are the main contribution of this paper.

2 Background

In 2012, the results of a study carried out by the United States Administration on Aging (AOA) reported that only 44% of older persons assessed their health as excellent or very good. About one in three seniors reported some type of disability (i.e., difficulty in hearing, vision, ambulation, self-care, or independent living) [8].

During normal aging, older adults experience a series of age-related-function limitations. Vision decline, hearing loss, motor skill diminishment and cognitive decline are the most commonly accepted age-related function limitations [9], [10]. Vision decline includes eyesight weakening, decline in color perception, sensitivity changes, and contrast sensitivity, as well as pupil shrinkage. Hearing loss results in hearing capacity diminishment, and in some instances, complete hearing loss. Motor skill diminishment results in slower response time and inflexibility of movement. Cognitive decline with age includes short-term memory and attention decline, spatial cognition and language comprehension decline [11]. There are also psychological changes. Loss of social importance and power due to the disengagement of an active social role [12], identity crisis, and a loss of self-esteem, are a few of the major psychological changes the aging population face which threaten their ability to live safely and independently [13].

The implications of these limitations in the design of user interfaces have gathered attention from researchers and there is a number of studies on how to better design user interfaces for older adults, for e.g. [14], [15] [16], [17], [18], [19], [20], [21], [22].

2.1 Active Aging and the Importance of Regular Physical Exercise

To respond to this inevitable but predictable global phenomenon of aging, the World Health Organization (WHO) has adopted the term ‘active aging’ to express “the process of optimizing opportunities for health, participation and security in order to enhance quality of life as people age.” [5]. Active aging conveys a more inclusive message than ‘healthy aging’. It helps people to recognize the factors in addition to health care that affect how individuals and populations age [23]. Such factors, or ‘determinants’ of active aging include: health and social services, economic, social, physical, personal, and behavioral.

This paper focuses on behavioral determinants, more specifically, physical activities. Research shows that participation in regular physical activity can substantially reduce the severity of disabilities associated with heart disease and other chronic illnesses [2]. Regular exercise reduces the risk of cardiac death by 20 to 25% among

people with established heart disease [3]. Physical activity also reduces the risk of falls [4]. Being active can help older adults be more physically and mentally fit, while also often promoting social contacts, and reducing medical expenses [5]. Keeping a healthy lifestyle and promoting active living of seniors will benefit both older adults and society in general as it reduces financial burdens while increasing human capital.

2.2 Exercise and Healthy Living through the Smartphone Market

Nielsen Newswire reported that 61% of recent mobile phone owners in the U.S., chose smartphones [7]. Specifically for the aging population, 57 % of the mobile users aged 55+ currently own smartphones [24], as penetration among this demographic group has nearly doubled over the past year [7]. At the same time, wealth and spending habits of older adults are hard to ignore. In 2010, according to the Bureau of Labor Statistics, disposable income for Americans 50+ was over $3 trillion and that age group also accounted for almost one half of all expenditures [25]. Analysts point out it is a misperception that "the 50+ are technologically challenged and unplugged." [26].

If one browses an app store one finds countless health and fitness apps that monitor and promote physical exercise or support healthy diets. These offer users the possibility to enjoy a personalized experience, setting up their own challenges and monitoring their progress. Compared to stationary treadmills or video exercises, users can enjoy exercising outside because smartphones and their apps are convenient to carry. Internal sensors keep the record of progress and achievements while the individual exercises. If a user adds external sensors, they can also monitor biometric data. Some apps can be used with a health purpose, this includes activity monitoring and falls detection [27]. Many apps are often free to use and offer multimodal and interactive functions. Most of all, many apps try to make it fun to exercise by creating a gamified environment for users. Apps with gamification elements are designed to persuade and motivate users to exercise more. Numbers of studies illustrate how gamification can play a role in motivating users in certain behaviors [27], [28], [29], [30]. Social networking features also play a motivational role, this is especially important for people 50+, whose goal of playing a game is often to socialize [31].

3 Methods and Tools

The goal of this paper is then to verify if some of the most popular apps that are popular today are ready to be used by older adults. This section describes the process followed to address this goal.

There is a large number of methods to assess the usability of user interfaces [32], [33]. One of the most popular methods to perform usability inspections without requiring much experience, training, time and money is heuristic evaluation [34], [35]. Moreover, this method has been largely applied offering positive and valid results [35], [36] . For these reasons, this was the method chosen for this study.

Nielsen provides a list of 10 Usability Heuristics for User Interface Design [37]. The general character of this list would apply to the context of this study, however

that list had not been created to specifically address the design of user interfaces for older adults users. Therefore, and given the fact that heuristic evaluation also gives the flexibility to define a different list of heuristics depending on the user interface being evaluated, a different list was used (Table 1). This list was the result of the combination of [16],[17],[15],[22] and is organized in six categories: perception, cognition, dexterity, navigation, content, and visual design.

Table 1. List of 35 heuristics used in the heuristic evaluation

Heuristic Number	Heuristic Description
	Cognition
H1	Focus on one task at a time instead of requiring the user to actively monitor two or more tasks, and clearly indicate the name and status of the task at all times.
H2	Avoid the use of interaction timeouts and provide ample time to read information.
H3	Avoid the use of animation and fast-moving objects.
H4	Leverage mental models familiar to older adults.
H5	Reduce the demand on working memory by supporting recognition rather than recall.
H6	Aim at creating an aesthetical user interface, by using pictures and/or graphics purposefully and adequately to minimize user interface clutter and avoid extraneous details.
	Content
H7	Give specific and clear instructions and make help and documentation available. Remember that it is better to prevent an error than to recover from it.
H8	Provide clear feedback and when presenting error messages make them simple and easy to follow.
H9	Make sure they are descriptive and use meaningful words and verbs when requiring an action.
H10	Write in a language that is simple, clear and adequate to the audience.
	Dexterity
H11	Avoid pull down menus.
H12	Avoid the use of scrolling.
H13	Enlarge the size of user interface elements in general; targets should be at least 14mm square.
	Navigation
H14	Keep the user interface navigation structure narrow, simple and straightforward.
H15	Use consistent and explicit step-by-step navigation.
H16	Make sure that the "Back" button behaves predictably.
H17	Support user control and freedom.
H18	Disable inactive user interface objects.
	Perception
H19	Allow users to fine tune the volume.
H20	Do not rely on color alone to convey information. Be aware of color blindness.
H21	Provide not only visual feedback, but also tactile and auditory.
H22	Make information accessible through different modalities.
H23	Use lower frequencies to convey auditory information such as confirmation tones and alerts.
H24	Do not use pure white or rapidly changing contrast backgrounds.

Table 1. (*continued*)

H25	Make it easy for people to change the text size directly from the screen.
H26	Allow users to fine-tune screen brightness and contrast.
Visual Design	
H27	Use high-contrast color combinations of font and/or graphics and background to ensure readability and perceptibility; avoid using blue, green and yellow in close proximity.
H28	Use color conservatively, limiting the maximum number of colors in use to ~four
H29	Make sure text uses types, styles and sizes appropriate to older adults, for instance, but not exclusively: sans serif, non-condensed typefaces, non-italic, left justified and 12-14 point font.
H30	Make links and buttons clearly visible and distinguishable from other user interface elements.
H31	Make information easy to read, skim (or) and scan.
H32	Group information visually (make good use of color, text, topics, etc.).
H33	Allow sufficient white space to ensure a balanced user interface design.
H34	Use user interface elements consistently and adhere to standards and conventions if those exist.
H35	Use simple and meaningful icons.

3.1 Choosing the Apps to Inspect

There are numerous mobile apps available in the market. Evaluating them all would represent a herculean effort. It was then necessary to determine specifically which apps to analyze. This paper first started by reviewing the market distribution, concluding that Android and Apple iOS combine for 82.1% of all smartphone platforms worldwide [38]. For this reason, this study decided to focus on these two platforms. It was then necessary to determine specifically which apps to analyze.

In October 2013, the authors searched the iTunes Store and Google Play, the Apple and Android app stores respectively, first for top popular systems by age, but, outside of kid's apps, neither store signifies popularity by age of user. The study then moved on to identify the top 20 apps in health and fitness, both paid and free, for both platforms. Once the list of 80 apps was generated, the apps were coded as either: exercise, weight management, or monitoring. The authors chose to work with the free exercise group of apps as those would not present a financial barrier for utilization. Finally, the authors kept only the apps that directly tracked physical exercise: Nike+ Running by Nike, Inc. and RunKeeper – GPS tracker by FitnessKeeper, Inc. (Table 2).

Nike+ allows the user to use the phone as the tracker or manually input information. Nike+ operates a traditional leaderboard where users can set goals, track their history, play against themselves or compete against others. The app also has features for more socialization either through the leaderboard or the connections to traditional social media.

RunKeeper, like Nike+, tracks your progress and history. The leaderboard interface allows the user to compete against themselves or others to earn points and badges. It also uses push notifications to increase motivation and has a large socialization component that interacts with Facebook, Twitter and within the app itself.

Both Nike+ and RunKeeper make use of the smartphone embedded sensors; these can be used alone or in combination with external sensors that allow the user to track their exercise.

Table 2. Nike+ and RunKeeper Characteristics

App	External Sensor Usage	Games Elements (PBLs)	Mechanics
Nike+	External sensor (in the form or a band or watch) option for purchase. But can operate without it; in this case the application uses the smartphone internal accelerometer or the internal accelerometer plus GPS of the smartphone.	Points exist and are awarded in the form of 'NikeFuel' and badges help track goals and milestones. Heavy use of leaderboard for tracking, goal setting, milestone marking an social networking.	Strong social networking aspect. Has competition aspect as well. All operated through Leaderboard.
Runkeeper	Internal sensors, that is the accelerometer, GPS and Bluetooth radios embedded in the smartphone.	Points and Badges used to help track goals and milestones. Heavy use of leaderboard for tracking, goal setting, milestone marking a social networking.	Strong social networking aspect. Has competition aspect as well. All operated through Leaderboard.

3.2 Evaluating Nike+ and RunKeeper

While five would be the recommended number of evaluators to perform a heuristic evaluation, three corresponds to the necessary minimum number of evaluators and still allows the evaluation to find more than 50% of the problems in the user interface [39]. This study involved three evaluators (the authors of this paper), one of them had performed heuristic evaluations professionally, and the other two had not. Still, they were well acquainted with the procedures of heuristic evaluation (having had received training on how to perform a heuristic evaluation in a university course), the way in which touch-based mobile apps work, familiar with literature on how to design for older adults, and the understanding of the heuristics themselves. None of the evaluators was familiar with either of the apps.

Before starting the inspection, the evaluators received an Excel spreadsheet as well as a list of procedures (available on request). The excel file contained the list of 35 heuristics and served for evaluators to record the problems they had found in the user interfaces as well as the time spent on the evaluations. The list of procedures advised the evaluators to, individually, go through the interface at least twice: the first, to get a feel for the flow of the user interface; and, the second, to focus on the specific user interface and identify possible problems and violations of heuristics; this is the recommended procedure for conducting a heuristic evaluation [39].

Besides evaluating the overall application, the evaluators were requested to dedicate special attention to the areas that are fundamental for the users' onboarding and for the activities considered necessary to effectively use the gamified apps. These included: registration and login; setting a quest; monitoring own progress; checking own achievements; and, assessing own achievements by comparing and competing with others.

Finally, the evaluators were directed to clearly describe each problem identified in the user interface with reference to its violated heuristic(s) and, if desired, an image demonstrating the problem. Moreover, the evaluators should try to be as specific as possible and should list each usability problem separately.

For consistency purposes, the evaluators were advised not to use the physical buttons of the phone itself; this was the case because there is a significant difference between Android and iOS phones, since the first generally have a back button incorporated in the device itself, being it digital or physical, while the iOS phones have only a home button.

Both the Android and the iOS versions of Nike+ and RunKeeper were evaluated. The first were inspected on phones running Android 4.1.2 Jelly Bean (a Samsung Galaxy Rush, LG Optimus F3, Samsung Galaxy s4) while the last were evaluated on iPhone 4. No directions were given to evaluators regarding the order in which evaluations should be performed, but at the end, all evaluators started by evaluating the iOS versions of the apps.

On average the evaluators spent between 20 and 40 minutes performing their first review of the user interfaces and between 55 and 98 minutes to perform the second one (Table 3).

Table 3. Time spent inspecting the user interfaces per evaluator and app

	Application	#1	#2	#3	Average time (min)
1st review	Nike+ iOS	30	45	45	40
	Nike+ Android	25	20	20	25
	RunKeeper iOS	20	25	20	22
	RunKeeper Android	25	25	10	20
2nd review	Nike+ iOS	90	85	120	98
	Nike+ Android	70	60	100	77
	RunKeeper iOS	60	55	100	72
	RunKeeper Android	60	45	60	55

4 Findings

Table 4 summarizes the most important data collected from this study and shows the total gross number of problems found by all evaluators, that is: without removing possible repetitions among evaluators. Overall, the heuristic evaluation identified a total number of 536 heuristic violations, being 191 and 170 of those identified in Nike+ and 93 and 82 of those identified in RunKeeper, for the iPhone and Android versions respectively.

The heuristics with the most violations across all platforms and with more than 30 or 6% of the violations, in descending order, are:

- H35 – Use simple and meaningful icons – with a total of 49 problems, or ~9% of all problems.
- H27 - Use high-contrast color combinations of font and/or graphics and background to ensure readability and perceptibility; avoid using blue, green and yellow in close proximity – with a total of 44 problems, or ~8% of all problems.

Table 4. Number of heuristic violations identified in the evaluation

	Heuristic Number	Nike+ iPhone	RunKeeper iPhone	Nike+ Android	RunKeeper Android	Total by Heuristic	% within Category	% in Total
Cognition	H1	1	1	2	1	5	9	1
	H2	2	1	2	1	6	11	1
	H3	2	2	2	1	7	13	1
	H4	5	1	5	1	12	23	2
	H5	0	0	3	1	4	8	1
	H6	7	1	9	2	19	36	4
	Total	**17**	**6**	**23**	**7**	**53**		**10**
Content	H7	7	1	7	2	17	35	3
	H8	9	1	6	0	16	33	3
	H9	3	1	1	1	6	12	1
	H10	8	1	1	0	10	20	2
	Total	**27**	**4**	**15**	**3**	**49**		**9**
Dexterity	H11	0	1	12	0	13	20	2
	H12	5	3	6	2	16	25	3
	H13	18	10	1	7	36	55	7
	Total	**23**	**14**	**19**	**9**	**65**		**12**
Navigation	H14	15	6	10	5	36	40	7
	H15	4	2	3	3	12	13	2
	H16	2	0	2	0	4	4	1
	H17	12	8	11	2	33	37	6
	H18	1	1	1	1	4	4	1
	Total	**34**	**17**	**27**	**11**	**89**		**17**
Perception	H19	4	1	3	3	11	12	2
	H20	1	0	4	2	7	8	1
	H21	3	2	3	2	10	11	2
	H22	1	1	3	1	6	7	1
	H23	3	2	1	2	8	9	1
	H24	2	1	1	1	5	6	1
	H25	11	9	7	7	34	38	6
	H26	2	2	2	2	8	9	1
	Total	**27**	**18**	**24**	**20**	**89**		**17**
Visual Design	H27	8	12	13	11	44	23	8
	H28	0	0	0	0	0	0	0
	H29	10	8	13	11	42	22	8
	H30	9	1	8	2	20	10	4
	H31	1	1	1	1	4	2	1
	H32	1	0	1	0	2	1	0
	H33	3	1	2	0	6	3	1
	H34	11	3	9	1	24	13	4
	H35	20	8	15	6	49	26	9
	Total	**63**	**34**	**62**	**32**	**191**		**36**
	Total by app	**191**	**93**	**170**	**82**	**536**	**100**	**100**

- H29 – Make sure text uses types, styles and sizes appropriate to older adults, for instance, but not exclusively: sans serif, non-condensed typefaces, non-italic, left justified and 12-14 point font – with a total of 42 problems, or ~8% of all problems.
- H13 - Enlarge the size of user interface elements in general; targets should be at least 14mm square – with a total of 36 problems, or ~7% of all problems.
- H14 - Keep the user interface navigation structure narrow, simple and straightforward – with a total of 36 problems, or ~7% of all problems.
- H25 - Make it easy for people to change the text size directly from the screen – with a total of 34 problems, or ~6% of all problems.
- H17 - Support user control and freedom – with a total of 33 problems, or ~6% of all problems.

From these, H14, H25, H27, H29 and H35 are systematically violated (five times or more) in each of the apps.

The analysis of the data per category shows that the category with the most violations is Visual Design, followed by Navigation and Perception. The three remaining report lesser problems, but are still significant. When looking at the data inside each category, in the Cognition category, H6 - Aim at creating an aesthetical user interface, by using pictures and/or graphics purposefully and adequately to minimize user interface clutter and avoid extraneous details - is the most violated heuristic, accounting for 36% of the violations. In the Content category, the greatest percentage of problems is distributed by H7 - Give specific and clear instructions and make help and documentation available. Remember that it is better to prevent an error than to recover from it - and H8 - Provide clear feedback and when presenting error messages and make them simple and easy to follow, with 35% and 33% of the violations. In the Dexterity category more than 55% of the problems are with H13 - Enlarge the size of user interface elements in general; targets should be at least 14mm square. The Navigation category has the majority of the problems being found with H14 - Keep the user interface navigation structure narrow, simple and straightforward - and H17 - Support user control and freedom - with 40% and 37% of the violations respectively. Looking at the Perception category, H25 - Make it easy for people to change the text size directly from the screen - appears to be the most problematic, with 38% of the problems. Finally, the Visual design category has its majority of problems distributed among H27 - Use high-contrast color combinations of font and/or graphics and background to ensure readability and perceptibility; avoid using blue, green and yellow in close proximity, H29 - Make sure text uses types, styles and sizes appropriate to older adults, for instance, but not exclusively: sans serif, non-condensed typefaces, non-italic, left justified and 12-14 point font, and, H35 - Use simple and meaningful icons, with 23%, 22% and 26% respectively.

Normally, a debriefing session takes place after consolidating the problems found by all evaluators individually, with the goal of creating a set of proposed design solutions. However, since the goal of this study was to understand to what extent the user interfaces of the apps were already accommodating older adult users and not to deliver a list of usability problems to a design team, the authors have not produced such a list, nor were severity ratings and priority of correction attributed to the problems

found. However, the violations evidenced in this analysis severely prevent seniors from engaging, starting, or enjoying the apps.

5 Discussion

The analysis performed considered the gross number of problems the evaluators identified, that is: after receiving the results from each of the three evaluators, the list of problems was not consolidated. This means that possible repetitions of problems were not removed. This may somehow inflate the number of errors reported. Also, heuristic evaluation does not replace user testing, and it would be positive to complement these results with studies involving actual older adults. Nevertheless, due to the exploratory character of the study we believe the results of the study are significant and do indicate that the apps inspected violate basic principles of user interface design for older adults.

A practical advantage of heuristic evaluation is that once a user interface problem is identified it is relatively easy to provide a solution for it and when looking at the five most frequent violations identified by this study, one realizes that the corrections for those are fairly 'simple'. The fact is that their correction would likely remove the barriers of entrance and use of these apps by the aging population. Moreover, its correction would not harm the experience with the user interface by other possible users of the apps and would possibly even improve their experience.

6 Conclusions and Future Work

This study showed that Nike+ and RunKeeper do not comply with standard needs for successful use by the older adult population. The inspected apps persistently showed the violation of a number of heuristics, being the ones more often violated within the Visual Design category. These were followed by Navigation and Perception, however the categories of Cognition, Content, and Dexterity also had many violations.

It was out of the scope of this paper to produce a set of solution proposals, but given the ability to iterate the design of the apps inspected in this study, this could be done by following the normal procedures of a heuristic evaluation, that is: by generating a list of proposed solutions based on the list of problems and its severity and priority of correction. Another interesting possibility for future work is the creation of a patterns language that can then be integrated with an IDE so developers would have access to the patterns necessary to avoid these mistakes in the design of future apps. The patterns derived from this work could for instance complement the work of [18].

We hope to have raised awareness to the issue of overlooking the senior user in the apps domain, because the issues of usability identified are relatively easy to solve, but are indeed impeditive of use by this special target population.

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