A smartphone based approach to enhance older persons' mobility in daily life

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M. Haeger, O. Bock, W. Zijlstra. A smartphone based approach to enhance older persons' mobility in daily life. Gerontechnology 2017;16(2):109-114; https://doi.org/10.4017/gt.2017.16.2.006.00 **Objective** This paper aims to present a new approach for stimulating physical activity in older people. We created a new activity app to introduce older people to planning trips in their hometown using a smartphone, and hence increase activity. This paper presents our methodological approach and the functionality of our new app. Furthermore, we will present preliminary results for feasibility. **Methods** We used MIT App Inventor 2® to create an application for more mobility in older age. We planned two trips per week with increasing walking duration (range: 900m-4500m) over eight weeks. Moreover, we use questionnaires for system usability and individual feedback to test the feasibility of older persons using this gadget. Tests on cognition, gait, and mobility are only described and results will be presented after study completion. **Results** The first ten older adults finished the intervention. Their results indicate an acceptable usability (mean score 70.50 ±12.41) and significance ($F = 9.217$, $p = .004$) increased walking distances between the activity blocks. **Conclusion** First results of our approach indicate an acceptable usability, so we presently extend our sample size to evaluate the effects on cognition, gait, and mobility.

Keywords: application, usability, elderly people, smartphone, mobility

It is well established that structured physical exercise and habitual physical activity of daily life both have a positive influence on health[1-5]. There are general recommendations, such as 10.000 steps per day or two-and-a-half to three hours of moderate to moderate-vigorous activities per week, for a healthy and active lifestyle[6-8]. Unfortunately, however, recommended weekly activity levels are maintained by only about 50 percent of persons aged 60+ when assessed by self-reports and by only 10 percent when registered by objective methods[9]. Moreover, activity continues to decline with advancing age as the duration and frequency of physical activities decreases[10-12]. Furthermore, the recommendation of 10.000 steps for example showed only evidence for a special population[13] and might be an ambitious target for frail older people.

One approach to enhance physical activity in older persons is to offer structured physical exercise classes, such as aerobic fitness or resistance training. This has been shown to prevent physical impairments in older age[14].

There are many older adults which don't enroll in physical exercises or drop out after a short time. A recent review of 132 studies[15] concluded that "Many older people still believe that physical activity is unnecessary, risky or even potentially harmful; others recognize the benefits to improve physical and mental well-being, but report a range of barriers to physical activity participation". The authors of that review conclude that adherence levels of older people could be raised by two strategies: "(I) raising awareness of health benefits and minimize the perceived risks of physical activity, and (II) the improvement of environmental and financial access to physical activity opportunities"[15]. Additionally, we believe that a third strategy should be considered as well: adherence levels could be raised by (III) the implementation of ecologically valid training regimes. Such a training approach reflects the characteristics of everyday life[16]. A range of studies observed that motor behavior[17,18] and cognitive performance[19] in standardized, well controlled situations differs from that in everyday life[20]. One reason for this difference is that everyday activities typically entail an interplay of physical, cognitive and social demands[21]. In line with our assumption, Franco and colleagues[15] used in their review for example the ecological model from Bauman et al.[22] for the interpretation of their results. The described interaction of different strategies is a main principle of ecological models[22].

A promising first step towards implementing the above strategies in a new training approach is the advent of smartphone-based mobility applications, such as Runtastic PRO® and Runkeeper®. These applications contribute little towards strategy (I), awareness of benefits and risks, but they support strategy (II), financial and environmental access. This is so because smartphones are nowadays available in a majority of western country homes[23] and ownership continues to grow, because applications are available free or at only a small fee, and because the supported activities can take place anytime at any convenient location. Mobility apps also contribute towards strategy (III), because they could be used every time a day in a natural environment. Apps like Runtastic PRO® or Runkeeper® for example can be used for different indoor and outdoor activities. They have also additional features like a robotic voice, which gives some feedback (i.e. duration, speed, pace)[24,25], or possibilities for social networking[25]. However, most smartphone applications don't enhance the interplay of physical, cognitive and social demands any more than classical training regimes do, but they provide several motivating elements: available apps allow users to choose autonomously when and how to be active, provide guidance with respect to a suitable activity level (i.e. steps per day), and enable social support by internet user groups. These motivating elements (i.e. autonomy, competence, and social contact) are described by Self-Determination theory[26,27] and Physical Activity Facilitation theory[28,29]. It has indeed been proposed that motivation is an important prerequisite for remaining physically active[30].

The present study introduces an ecological training approach, using a new developed application called Mobility in Age (MIA), which goes beyond the available mobility apps with respect to the third strategy above. Our approach enhances the interplay of physical, cognitive and social demands since activities are cognitively challenging and are carried out in small groups with rotating roles. Our approach also enhances the motivational aspect: the application gives users not only the freedom of choice but also presents information about possible activities: we believe that a choice between visiting a historical building or taking a stroll in a public park is more motivating than a choice between 10.000 or 12.000 steps. Furthermore, it takes the users' competence into account since it is introduced to users by a human instructor who initially explains how to operate the app, helps participants use it, and accompanies them on their way; in accordance with established coaching principles the instructor's contributions gradually fade out as users' competence increases. At least, it provides social support since activities are undertaken by small groups, which encourages real rather than virtual socialization.

We developed this approach including our app in order to increase older people's daily activity through interesting and motivating trips in and around their hometown. Subsequent studies will further analyze usability and the potential effects from using this app on cognition and gait, as well as mobility in older age. Main outcomes will be to see (i) whether our ecological valid approach including a smartphone app is usable for older people and (ii) if there are activity-induced benefits for health of older people. This paper aims to describe our approach, its underlying reasoning, and present preliminary data for feasibility.

Materials and Methods

We developed a mobility app using the online platform App Inventor 2®, This platform provides a programming environment for Android® based smartphones, based on a drag-and-drop builder and many possibilities to include additional data (i.e. pictures, videos, or audio).

After a password-protected login, users of our app can choose one out of four activities in and around their hometown, i.e., Cologne, Germany (*Figure 1*). Each activity is briefly described, and users then select the one they prefer on their own. Once an activity is started, it can't be aborted; if the app is disabled by logging out, pressing the "home" button or by a system crash, it will return to the most recent screen with the next restart. Furthermore, each given activity can be undertaken only once, after completion it will be blocked. Each activity consists of directions about how to reach the planned destination, an informative text about this destination, and a short quiz about peculiarities along the trip. This quiz consists of three or four questions and is presented nearly at the end of each trip. All informative text is presented in writing and optionally also in spoken form; it can be repeated when desired. Correct quiz answers are counted and the total score is presented at the end of each activity, along with correct answers. All information and the quiz should induce an active participation as well as increase attention to peculiarities along the trip.

Once a given number of activities are completed, a new block of activities is enabled, etc., for a total of presently four blocks. The activities are selected such that physical effort (i.e., meters walked) increases from one block to the next. One benefit of subdividing the app into blocks is that the software can be accommodated within the limited resources of the App Inventor 2® platform. All activities are listed in *Table 1* only with their titles. Each title belongs to a destina-

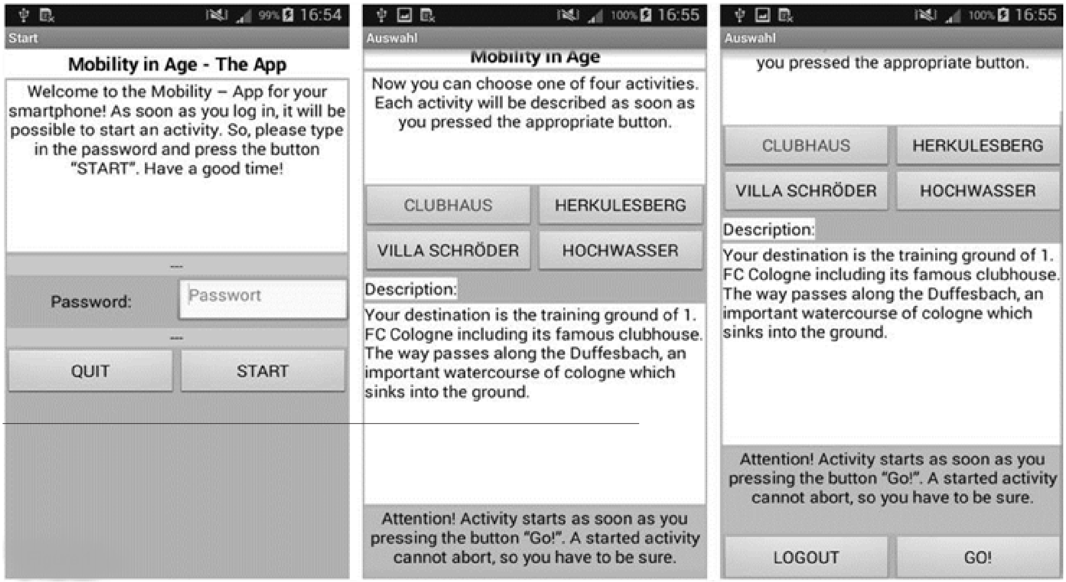

Figure 1. Login screen, different activities including description, and same screen scrolled down (from left to right)

tion of the trip. They all have a common starting point, the German Sport University Cologne.

We planned a controlled trial to test feasibility of our approach. Study design is approved by the Ethics Commission of the German Sport University Cologne. Our target group consists of older people (age ≥ 70 years) without cognitive impairment (MMSE > 23). Further exclusion criteria are using a walker or walking-related restrictive diseases (e.g. Peripheral Arterial Disease, Parkinson's disease). Each participant has to sign an informed consent statement before being involved. Participants will be recruited in Cologne by distributing flyers or using mailing lists.
All participants will be separated into two equal groups (i.e. intervention, control): intervention group (int) takes part in an eight-week walking program; control group (con) takes part in a biweekly series of lectures. We planned three testing sessions: baseline (I) includes participants' characteristics, questionnaires for motivation and personality, computerized cognitive tests for executive function (i.e. inhibition, switching) and orientation, and gait and real life mobility; a further session (II) after four weeks includes computerized tests and questionnaires; and a post-test (III) which includes questionnaires, computerized tests, as well as gait and real life mobility.

Table 1. Planned walking distance in meter (m) for individual activities on each intervention-block. All activities are translated with German names in parentheses unless it is a proper name

Part	Activities	Planned walking distance
1	Rosarium (Rosengarten) Boccie (Boccia) Old Piano (Klimperkasten) St. Gereon	≈900m – 1300m
2	Sculpture Park (Skulpturenpark) Cologne-Kalk (Köln-Kalk) Cathedral (Dom) Neo-Gothic (Neogotik)	≈1600m – 2100m
3	Villa Schröder Billy Goat Home (Geißbockheim) Mount Hercules (Herkulesberg) High Water (Hochwassertour)	≈2400m – 2800m
4	Cologne & Sport (Köln und Sport) Keep Fit (Trimm-Dich) 1910-1913 Churches in Spirit of the Time (Kirchen im Zeitgeist)	≈3000m – 4500m

For feasibility testing, participants are asked to give some subjective feedback about their experience. Furthermore, their satisfaction with our app will be quantified by the System Usability Scale (SUS)[31-33].

Our mobility app is meant to be used by groups of up to five persons, to provide new social contacts and bonds. It should be used about twice per week, to ensure continuity yet allow free days for rest and contemplation. The app should be introduced by a tutor who explains software use and guides the group on its initial trips. Later on, the tutor should assume a passive role and come along mainly for safety; group guidance should then rotate between participants. The role of the tutor could be described as "faded guidance", in analogy to the term "faded feedback" established in motor learning research[34]. When the group starts the application it would present the possible activities. If they choose one activity, the app would describe a train or bus station in the area of the destination as well as a written description of a route from this sta-

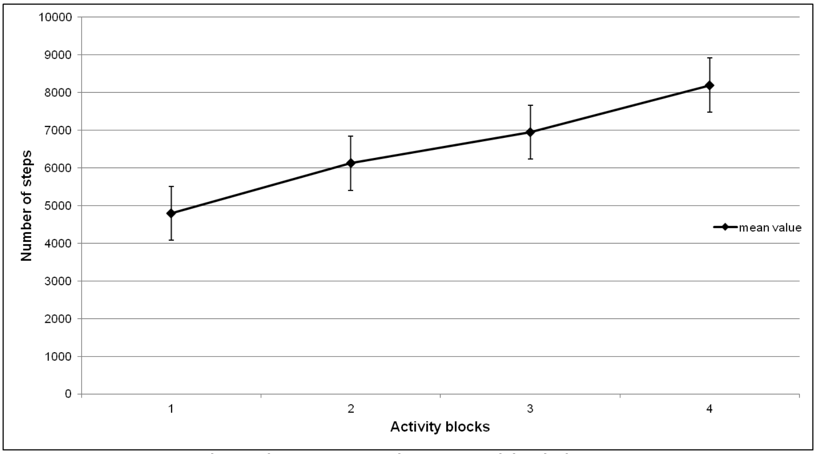

Figure 2. Mean number of steps in each activity block from one intervention group (n = 10), including standard error of measurement

tion. Now, participants could use implemented maps of the train-network and around the destination to plan their way. There is no interactive route system on the screen so they have to keep the route in their mind.

Additionally, to monitor participants' actual effort, we estimate for each activity the mean number of steps by step counters (Omron Walking Style IV, earlier models showed an acceptable accuracy)[35,36].

Preliminary Results

Ten healthy, community-dwelling older adults (5 men and 5 women, mean age of 76.5 ±3.60 years, no gait-related impairments by self-report) volunteered to participate. All participants completed, as a group, all sixteen activities of *Table 1* within eight weeks. The "faded guidance" principle (see above) was applied, and participants then took turns as tour guides. The average number of steps during each activity block was registered by a pedometer. The outcome, shown in *Figure 2*, indicates that the number of steps increased from block to block as intended (see Methods); this increase was statistically significant (repeated-measures ANOVA with factor Block: $F = 9.217$, $p = .004$). Measurements of user satisfaction yielded a mean score of 70.5 (±12.41), where 100 represents complete satisfaction. Participants described our app approach as an 'interesting' and 'usable tool'. However, those without a smartphone were not interested in it.

Discussion

According to our pedometers, the new mobility app successfully increased older persons' step count from block to block. In fact, our plan for increasing walking durations during the ecological valid intervention was approved. The resultant usability score suggests that the app was well received and usable for older people. However, a score of 70.5 represents as well the lower limit of an acceptable usability[37]. So, it seems to be a feasible approach to increase physical activity using our app. Furthermore, we should continue to improve our app in terms of usability.

Moderate walking intensity for health promotion is around 100 steps per minute[38]. However, these recommendations were developed for adults in general and not for a specific age group or persons with low fitness level. Additionally, there is only limited evidence supporting this statement[8]. Previous pedometer interventions in older adults showed mean improvements of nearly 800 steps per day[8]. For persons with low fitness a marginal increase of their daily activities might be beneficial for their health. Our results showed mean values of nearly 5.000 to 8.000 additional steps depending on the activity, on each of two days per week. So besides the benefits regarding increase of weekly physical activity, our approach offers a diverse and interesting way of implementing physical activity promotion, which combines physiological, social, and cognitive aspects. This approach including the new mobility app combines all three strategies above to increase physical activity in older age. The ecological model from Bauman and colleagues[22] consists of four levels: individual, social, environmental, and policy. Our approach addressed all of them except the policy. Furthermore, in view of usability, our approach worked well with the older adults. Results from the SUS and individual feedback indicate, that we created a usable app for those who own a smartphone. However, these are only first results from a small count of participants, including their subjective statements. So, we need more participants to make a final conclusion.

It would be desirable in the future to increase the number of activities. Sixteen activities within a time frame of eight weeks may not be enough to lastingly facilitate mobility, since other studies used longer intervention time[39,40]. Another desirable modification of the present app would be to register not only the number of steps taken but also the instantaneous step frequency, since about 100 steps per minute are needed to reach an aerobic intensity that represents light to moderate activity[38,41].

In the long run, we envisage a web-based mobility app hosted by city councils and tailored to the attractions of each respective community. This app could be downloaded by visitors and locals, thus serving both tourism and older person's health. If our approach is addressed to a specific population of older and inactive people, it would be possible to increase their mobility. However, as a next step, to substantiate our preliminary findings, we presently evaluate the benefits of training for participants' daily life. So, further outcomes of gait, mobility, and cognition will be presented after study completion.

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