Using persuasive features to promote physical activity for older employees – Report from the AgeWell project

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Abstract. Older people in the cusp of retirement are often concerned about their future and are worried that retirement means inactivity. The AgeWell project seeks to support them through their transformation to retirement and beyond. In this paper the development of the physical activity app is reported. Persuasive features as well as behavior change techniques were used to digitalize the requirements and wishes of the users for the app. Users tested the app for 10 weeks. Results indicate that more users were physically active after the testing period and showed appreciation towards various persuasive aspects of the app. The direction of future research can focus on understanding which persuasive features are most useful, and testing the level of use of an improved, flexible and intuitive system.

Keywords: physical activity, elderly, persuasive design, eHealth

1 Introduction

This paper reports[1] the application of behavior change techniques to promote physical activity of older adults in the retirement phase. All work reported happened within the AAL Joint Program project AgeWell[1]. The AgeWell solution provides activities for helping older workers and retirees aging healthy during the transition from work to retirement that can be life change entailing many risks for the physical and mental health of many older adults e.g., isolation, lack of interests, depression, laziness and lack of motivation in performing physical activity at detriment of their overall health and well-being. AgeWell provides an avatar on a mobile phone and robot (physically embodied device) based virtual coach. The system consists of 5 major components: the

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avatar, the physical activity reasoner, the mental health reasoner, a medical backend platform and the mobile robot companion.

Within this paper only the development of the physical activity reasoner and the idea behind it is reported. The procedure started with gathering insights from focus groups, followed by a review and selection of suitable items of the behavior change technique taxonomy (BCT) [2] and the Persuasive Systems Design framework (PSD) [3] which fit the requests. After conceptualization of the model the physical activity backend was developed including 20 physical activities. The whole solution was tested within a time frame of 10 weeks by 62 users, respectively 34 from Italy and 28 from the Netherlands. Quantitative and qualitative data were collected at three points in time: before the trial started, at the middle (week number 5) and at the end (week number 10), via online questionnaires and focus groups.

2 Methods

Since the AgeWell project follows a user-centric approach, focus groups were held with end-users at the start of the project in the Netherland(N=34), Austria(N=11) and Italy(N=10). The results give insights of what is important to users about a virtual coach. Concerning physical activity following points were stated by the focus group:

1. Autonomy is very important
2. The coach should identify if I set unrealistic goals and warn me, if I train too hard or too little
3. The coach should have a reminder function and help motivating me towards the goal

In a next step PSD and BCT items where identified which cover the points mentioned above. The selected items are shown in **Table 1**. As a result, the following requirements were made on the physical activity reasoner: It must be aware of the current physical capability of a user as well as set manageable goals based on previous performances via adaptive goal setting. The implementation of these two tasks is described in section 2.1. Furthermore, it must give the user autonomy. This is realized by providing the user multiple physical activities to choose from as well as giving him the choice to choose the activities he likes and overrule the adaptive goal setting by choosing his own goal (see section 2.2).

In order to give the users feedback and praise them, a motivational message corpus which consists of roughly 100 messages was used. Also, self-efficacy is important to motivate users which was realized with progress bars (see section 2.3).

Table 1. Important points stated by the focus group concerning physical activity with fitting items from the PSD and BCT and implementation.

Item No. Focus Group	BCT	PSD	Realisation
1	Action planning	Reduction	Users can freely choose which activities they want to perform when
2	Review behavior goals	Personalisation	Users receive each week a new goal which adapts to performance
3	Focus on past success	Praise	Advise to think about previous successes
3	Feedback on behavior	Self-monitoring	use of progress bars
3	Prompts/Cues	Reminders	Use of reminders for upcoming activities

2.1 Identify physical activity capability and setting realistic goals

To be most effective, it is necessary that the prescribed dose of exercises be tailored to an individual's current physical capability and desired health goals. In clinical practice, the FITT-VP principle of exercise prescription is used by experts to tailor physical activity goals. The principle suggests changing Frequency (f per week), Intensity (i e.g., light, moderate, vigorous), Time (t per session), and Type of exercise to adjust or progress exercise volume ($v = i \times t \times f$) per week that correlates with energy expenditure.[4] At this point Intensity is modelled via the type of exercise in the module (different exercise types have different intensities). Measures of dose, intensity and physical capability are central to coaching users in physical activity.

Exercise intensity is described based on energy demands of physical activity. It is measured through caloric expenditure also known as a MET (metabolic equivalent) that is defined as the amount of oxygen consumed while sitting at rest. A MET value for any physical activity is the energy cost expressed as a multiple of the resting metabolic rate.[5] For example, playing football has more METs than going for a walk. Therefore, choosing activities with a higher MET value requires less duration to meet the goal than choosing an activity with a low MET value.

In clinical settings, aerobic capacity is often precisely measured through elaborate tests of volume of oxygen consumption, or functional evaluations, such as 6-minute walk tests that are more relevant in deconditioned individuals. Given constraints of an app-based coach, these objective, clinical evaluations are difficult and costly to implement. Therefore, a self-report instrument was adapted, the International Physical Activity Questionnaire (IPAQ), which is a reliable instrument to assess baseline physical activity levels [6]. In the questionnaire, users report duration and frequency of physical activities in a typical week. These questions probe duration and frequency for low intensity (3 METs, such as stretching), moderate intensity (5 METs, such as fast walking), and vigorous activities (8 METs, such as playing football). Given these measures, an

individual's initial physical capability (in METs) can be computed. The implementation of the IPAQ is depicted in **Fig. 1**.

Apart from having an intensity measure with using MET values it was also used to motivate users, by providing them weekly credits equivalent to the MET values. With the abstraction from a time unit (e.g. 150 minutes) to a credit (e.g. 750 Credits) a gamification technique is used as well as users get driven away from focusing and worrying on how much time they must spend to reach their goal.

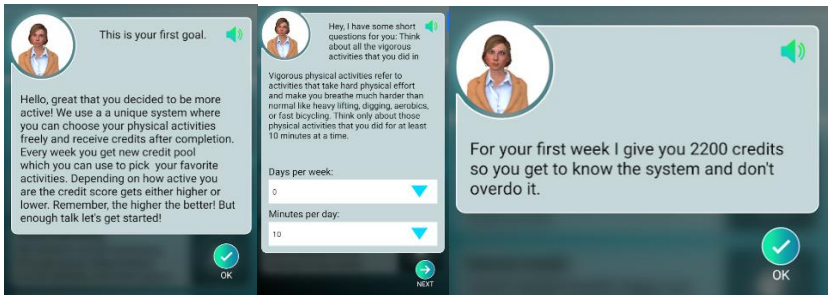

Fig. 1. Implementation of the IPAQ questionnaire

Beside setting a proper initial goal the fitness coach must be aware of the weekly performance and must set new manageable goals based on previous performances. Since no guidelines of how to increase/decrease physical activity based on previous performance are available in literature a handwritten rule is applied. Physical activity is increased when users perform more than 75% of their last goal. Specifically, for every percent higher than 75% their next goal is increased by 1% of the last goal. For example, a user which achieved 90% of his last goal gets an increase of 15% for the next goal. On the contrary, activity is decreased if users perform less than 75% of their last goal. However, for every percent lower than 75% their next goal is decreased by 0.33% of the last goal. As a result, the increase is much steeper than the decrease. The idea behind this application is that according to Kahnemann and Tversky's prospect theory, losses are weighting heavier than gains and should therefore be smaller to keep up motivation [7].

2.2 Ensuring autonomy

After users received their first weekly credits, they could freely choose between 20 activities (e.g. walking, swimming, gymnastics) they like to perform during the week. It is important to make the goal as precise as possible to raise the chance of completion (on which day, at which time, for how long) but at the same time give the users the autonomy the requested. Therefore, users planned only the type and duration of an activity and always had the chance to adapt it. The implementation is shown in **Fig. 2**.

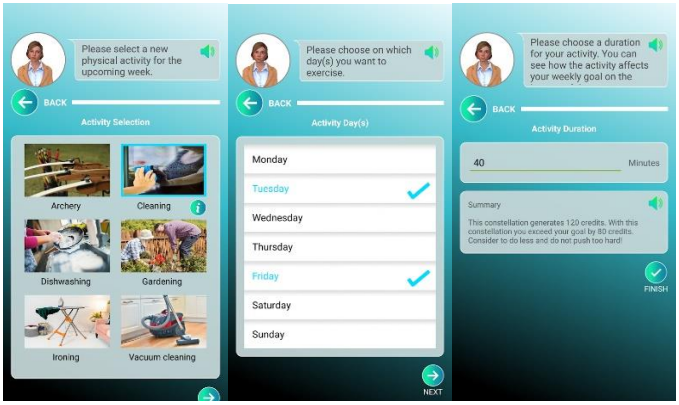

Fig. 2. Implementation of choosing an activity. Users could select the type of activity as well as the day(s) and duration. At the last screen they received a summary telling them how many credits they had left for the week. In this example, the user planned more activities then the coach has planned for him and therefore he gets an advice to not overdo it.

After an activity has been scheduled for a specific day, the user is asked at a predefined time if the activity was performed, as well as for specific feedback.

Although Intensity is implemented in the current module via different physical activities (METs), it also plays a role when asking users for feedback after activities. The Borg's RPE scale[8] was used to ask the exertion level of users on three levels, no – moderate – high exertion.

The reasoner chooses dependent on the answer a proper message. It will be positive in all cases since the user managed to do the activity. Furthermore, if he chose "no exertion" he additionally receives a message to increase the intensity the next time. If he chose "high exertion" he additionally receives a message to decrease the intensity the next time (see **Table 2**).

In case the user has not finished his activity, he is asked to provide a reason. Possible answers are:

- "It was too hard"
- "I had no time"
- "I had no motivation"
- "I don't think this is useful"

The reasoner chooses a proper message depending on the answer. If the user chose "it was too hard" he receives a neutral message as well as a message to decrease the intensity the next time (see **Table 2**). If he chose "I had no time" he receives a negative message as well as a message which motivates him to stick to the goal. If he chose "I had no motivation" he receives a message which should motivate him to do better the next time. If he chose "I don't think this is useful" he receives a message which provides information highlighting the benefits of physical activity. The implementation of answering to a scheduled activity is depicted in **Error! Reference source not found.**.

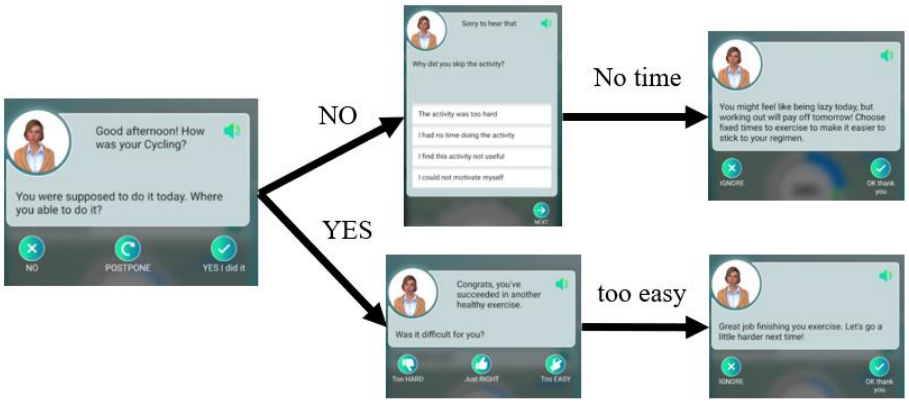

Fig. 3. Two possible outcomes of answering questions after a scheduled activity.

After a week is over the user receives a message including the credits he was able to achieve and get a new credit suggestion dependent on how active he was (see section 2.1 for details). However, to ensure user autonomy users can increase or decrease the credits for the upcoming week. The implementation is depicted in **Fig. 4**.

Fig. 4. Message at the end of the week. Information on how many credits were achieved is provided. A new credit suggestion for the upcoming week is included which can be adapted by the user.

2.3 Remind and motivate

Throughout the week the user receives every day a task is scheduled a reminder at a preferred time specified by the user in the settings. The reminder includes information on the type of activity and duration as well as motivation based on the feedback from the last time. Specifically, if the last activity was indicated as too easy a message is included which encourages the user to increase the intensity this time. If the activity was indicated as too hard the opposite is the case. (see **Table 2**). The user can skip,

postpone or take note of the message. The implementation of the reminder is depicted in **Error! Reference source not found.**.

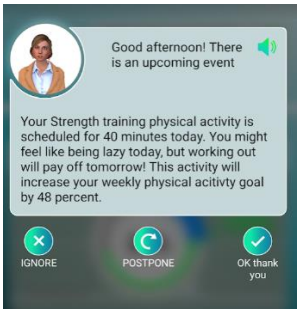

Fig. 5. Reminder for an upcoming activity.

For creation of the motivation message corpus the work of Vries et al[9] was used as starting point. They created an extensive corpus of messages via crowdsourcing which had the purpose to motivate for exercise adherence. A sub sample of this work was used in the AgeWell project, some of the messages were adapted and new messages were created. All messages were annotated to be ready for use by the reasoner.

Table 2. Types of motivational messages and example texts

Option	Example
Positive	You are on the right path! Stay there and hold on!
Increase next time	Next time you exercise, plan on pushing yourself a bit harder.
Decrease next time	You did great! I think it's important to keep in mind that you don't want to overdo it and hurt yourself though!
Neutral	Remember, changing behavior takes time. Don't be too hard on yourself if it sometimes doesn't work. It will get better next time.
Negative	Wouldn't it be worth for your own well-being to start exercising?
Motivation	Take care of yourself so your health doesn't become a burden on other people.
Information	Even small amounts of exercise every day are shown to significantly reduce the risk of heart disease
Increase before activity	Last time you did a lot, but I know you have it in you to increase the intensity.
Decrease before activity	After that great exercise the other day let's focus on keeping your intensity a little lower.
Positive weekly	You made it through the week! That wasn't so hard, was it? Keep up the good work!
Negative weekly	You didn't reach the goal this time, but it's all about consistency. Keep exercising!
Motivation weekly	You've put so much work into this thus far, it doesn't make sense not to keep it up.

In order to give users feedback on their activities progress bars are used (see **Fig. 6**). Users can watch their performance in the last five weeks and if they reached their weekly goal. Additionally, textual information is provided which puts focus on the positive aspects, motivating users.

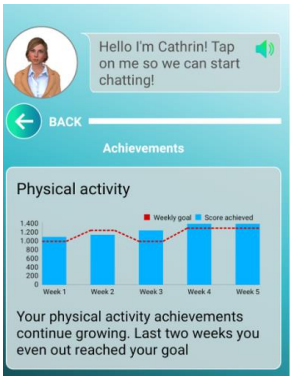

Fig. 6. Progress bar to boost self-efficacy with textual information and motivation.

3 Results

For the analysis app usage data and data from the three questionnaires and online meetings were used. Data from the questionnaires and focus groups were collected before the trial started, at the middle (week number 5) and at the end (week number 10) of the trials. Out of the 62 users 42 used at least one week the physical activity section in the app and were therefore included in the app analysis. 35 users completed all three questionnaires and were therefore included in the questionnaire analysis.

3.1 Results from the questionnaires

The questionnaires included quantitative questions with space for qualitative comments. Users were asked how active they felt on a 3-point scale. At the baseline 50.8% of them felt active or very active, while at the end of the trial 56.3% did.

The questionnaires also included the IPAQ, providing a quantitative measure for activity. Interestingly, users were significantly more days active in week number five than at the start of the trial (P=.027). However, there was no significant difference when comparing active days at the start of the trial with week 10 or active days in week 5 compared with week 10.

3.2 Results from the online group meetings

Participants from both countries expressed appreciation for the usefulness of the system for motivating the practice of healthy activities, including physical ones, and for

promoting active ageing attitudes and behavior. Particularly, the Italian participants recognized:

- the power of the system to motivate people to increase physical activity and to do it more regularly;
- the usefulness of receiving reminders to carry out activities suggested by the avatar;
- the importance of the app in helping users focus on their needs, including the physical ones.

3.3 Results from the app data

While using the app, users were asked for every scheduled activity if the duration of the activity they choose was either right or too short/long. Furthermore, they could indicate if the activity was too easy or too hard or reasons why they didn't do an activity. 1033 of scheduled activities were indicated as completed. In more than half of the cases the activity duration and intensity was just right. 2 times the activity was indicated as too hard and 335 times the activity was indicated as too easy.

66 times an activity was indicated as not completed, of which 2 times because of no motivation, 59 times because of not enough time and 5 times because the activity was not seen as useful to the user (see **Table 3**).

Table 3. Chosen answers to the question if a scheduled activity was done and answers to follow-up questions

	Activity duration was good	too hard	too easy	no motivation	no time	not useful
Activity Done	696	2	335			
Activity not Done				2	59	5

4 Discussion

This paper reported on the development of a physical activity app which includes the requirements and wishes of users via persuasive features and behavior change techniques.

4.1 Findings

Results show some positive outcomes from the use of the system for scheduling and performing physical activities. Participants reported positive feedback on the way the app motivated them with scheduling and carrying out physical activities, and in fact it was possible to observe their engagement with such activities through the analysis of quantitative data from the app itself. The increasing trend observed in the initial 5 weeks may have stabilized for the following 5 weeks for several reasons:

- they found their balance and did not want to increase their activities further
- they had problems remembering to record the activity as completed
- they fell ill or needed to drop their commitment slightly to care for someone else (impact of Covid, over 20% of participants infected throughout the trial).

Overall, the AgeWell app system seems promising, and with some adaptations can be a good solution for encouraging retirees to keep or become physically active.

4.2 Research added value

Given the lack of research regarding the promotion of physical activity for older adults[10] it is difficult to gather promising features from literature. Previous research already showed that co-design of fitness apps with the intended user, namely older adults, has a positive effect on technology experience[11]. Similarly, this paper highlights the benefits of adopting a user-centered design approach to select persuasive features and behavior change techniques. This brings advantages over choosing the features solely from theory or even randomly due to the lack of clear guideline on which feature works under which contexts. The approach presented here introduces a technique to gather the most important features for a specific target group and use-case when data on effectiveness of persuasive features and behavior change techniques is sparse.

4.3 Limitations

A limitation of the study is that participants were not asked to reflect on their process of change when using the app, i.e., whether they found it more helpful in changing their behavior to receive reminders or to view the progress bar graph. Although participants gave qualitative feedback on these two aspects, accurate quantitative data would have helped to observe whether they preferred one over the other.

Another limitation concerns the usability of the app was not so well perceived as some technical aspects need improvement, including its intuitiveness and flexibility in planning and recording physical activities. The findings would have probably been more positive if the system was further developed prior testing. However, a product cannot be finalized before it is tested, so feedback from participants will be useful to refine the product.

5 Conclusion

This paper presents a solution to use persuasive system design principles and behavior change techniques to motivate older adults in the retirement phase doing physical activity. It adopted a user-centered design approach to gather the most important features the solution should contain according to end-users and experts.

It was then tested on a sample of retirees and older workers who showed appreciation towards various persuasive aspects of the app which was confirmed by the number of

reported physical activities, particularly during the initial 5 weeks. The direction of future research can focus on understanding which persuasive features are most useful, and testing the level of use of an improved, flexible and intuitive system.

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