AAL PROGRAMME	**PersonAAL**	

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Physical Rehabilitation Demonstrator and Field Trial Plan

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Contributors: **All partners**

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Contents

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1 INTRODUCTION

This document describes the specifications of a system that supports elderly persons at home with emphasis on physical rehabilitation.

The deliverable contributes to Work Package 3, and specifically to the tasks T3.1 – Demonstrator Development and T3.2 – Field Trial Development. It extends and supersedes the deliverable D3.3a [14].

Physical rehabilitation is in this context related to interdisciplinary and home-based rehabilitation based on goals defined by the primary user. Norwegian literature defines this as home-based rehabilitation (hverdagsrehabilitering) [1]/[2]. Internationally similar approaches are referred to as reablement (United Kingdom), active service model (Australia) and restorative home support (New Zealand and USA) [3].

Home-based rehabilitation emphasises prevention and early intervention to prevent or delay extensive need for care. The main elements of this approach are:

- Early and intense effort to strengthen the users level of functioning and coping over a limited time period.
- Interdisciplinary effort directed at coping with physical activities in the user's home / local environment.
- The planning of initiatives based on goals defined by the user to ensure the attention is directed to the functions that are important for the user to strengthen or recover.

The physical rehabilitation application includes functionality directed at the latter element as described in this document.

The main goal of the PersonAAL project is to extend the time older people can live in their home environment, increasing their autonomy and assisting them in carrying out activities of daily living by means of intelligent and intuitive web applications.

PersonAAL primarily address elderly users that can be starting to suffer from some kind of functional (temporary or permanent) limitations or impairments typical of later age (vision, hearing, motor and/or cognitive). In order to facilitate the daily lives of older people, the PersonAAL platform monitors their behaviour through appropriate sensors and adaptively renders health-related information and quality of life improving suggestions on various devices existing at home through intuitive user interfaces.

Professional and especially informal caregivers, who generally have no specific professional technology training but have an intimate knowledge of the elderly, are our secondary users. The PersonAAL project builds easy-to-use environments exploiting

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novel metaphors, empowering caregivers to intuitively create, configure and personalise interactive services (e.g. patterns/scripts that could trigger specific events like notifications, warnings or alarms), to support older users in effectively managing and carrying out their daily tasks.

The outputs of PersonAAL are a platform for adaptation and personalization and three applications.

The platform [4] includes an authoring environment supports the specification of personalization rules, and a run-time support able to adapt and customize previously authored care applications to elderly users, their changing abilities, their environment and device characteristics.

This document describes the main features of the physical rehabilitation application and how it is integrated to the PersonAAL platform.

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2 DEMONSTRATOR DESCRIPTION

2.1 Objectives

According to the DoW [5] the main goal of the physical rehabilitation application was originally to increase or sustain the level of the physical functioning of the users by offering personalised exercises program for home-based physical training with automated feedback and remote guidance from formal care givers/healthcare personnel.

The scope of the application has changed as a new partner entered into the project and the main goal for the revised application is to increase or sustain the level of the physical exercise and activity of the users by offering personalised activity and exercises programs, based on guidelines for physical activity defined by Health authorities (WHO, Norwegian Health Directorate, Helse Norge) [6]/[7]/[8].

Physical activity is a key factor for sustaining an independent way of living for older adults including their mental functioning. This is well documented in research studies, however, comprehension of and compliance with training advices is still challenging. Hence, this application addresses monitoring of exercise and physical activity and provides feedback to the user based on goals and actual physical activity and exercise.

The physical rehabilitation application will provide functionality to define goals based on national recommendations for physical activity, make plans for the initiatives and self-reporting of the completion of the activities.

The application will also extend and use other activity tracking devices like the Fitbit [9] device to register and measure activity (e.g. daily activity summary, including parameters such as distance, active minutes, beat per minute, sleep). The application will integrate with the PersonAAL platform sending event and activity data to the platform and receive events to notify user and help change behavior. This shows how other vendors will be able to integrate and extend the PersonAAL platform.

For security requirements we refer to the "Privacy and Security in PersonAAL Platform" section in [4] and the new requirements defined by USI.

The UI will be developed using angular2 [10] and bootstrap [11] open source frameworks.

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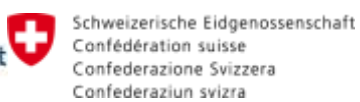

2.2 User Groups

The physical rehabilitation application will address three different groups of users:
i) Primary users: The main target group is elderly users at home who need to sustain or increase physical exercise and activity (preventive method to improve health).
ii) Secondary users/the informal caregivers; family & friends, charity services, etc.
iii) Secondary users/health care providers; general practitioners, physioterapists or ergonomists etc.

2.2.1 Primary end-user

The objective of the application is to support elderly users at home to sustain or increase the level of exercise and physical activity.

The low-threshold user-friendly interface will allow elderly users with low or no computer literacy to use the application on a tablet or smart phone. The wearable device will allow notifying and sending persuasions to the user in a non-intrusive way.

The application provides services such as planning and self-reporting of exercise and physical activity, monitoring the day-to-day activities.

2.2.2 Secondary users; informal caregivers

Friends and family and other informal caregivers are important contacts of the primary users, being the secondary users. The application will facilitate support of the daily lives of elderly people, by empowering informal caregivers who often do not have specific skills for the use of ICT but have an intimate knowledge of the elderly user at home. These informal caregivers will have access to the application and can follow-up on how the elderly is adhering to the activity goals. The informal caregiver can be given access, based on acceptance of the primary user, to the application, including the results as well as other reports.

2.2.3 Secondary users; health care providers

If requested by the primary user, the general practitioner or healthcare providers such as physiotherapists or ergonomists can assist the primary user to make an individual program for physical exercise based on national recommendations and the user's preferences and goals.

The primary user can also involve the health care providers in the evaluations of completed physical activity over time.

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2.3 Functionalities

The application includes a web application and app for smart phone and tablet with a simplified functionality suited to the elderly user, and a richer dashboard where the caregiver easily can get information and analytics based on the data gathered to monitor and help encourage the elderly user to sustain or increase the level of exercise and physical activity and make individual goals.

The application also incorporates integration with 3rd party activity tracker to allow the system to know even more about how the user is performing and following their avtivity plans. This data also allows the behavior and persuasion modules to use this data in analyzing the user. For this demonstrator, we have included the Fitbit activity tracker platform using the API they expose. In the future other devices can also be supported. The FitBit comes with a rich set of functionalities for setting goals, receiving feedback, seeing results and getting badges and encouragement among others. Our aim is not to replace this, but create the technology to integrate and use the fitbit data gathered into the PersonAAL platform so this data can be used by the other modules like persuasion model and the machine learning modules in the PersonAAL platform.

The application supports the following main tasks, detailed in section 2.4. Specifications and in section 2.5 UI mock-ups.

For the primary user (elderly person):

- Logon authenticating with PersonAAL Auth0. If user has not registered, an account can be created with Auth0, and then the user profile for the application is updated.
- A homepage welcomes the user and through the homepage the user can access and administer:
    - Daily Activity Summary and daily goals including; Weekly goals for activity in hours/minutes (walk, dance, exercise, swim, housework, play with grandchildren, strength and balance excersises) based on guidelines from global and national health authorities
    - Exercise and physical activity completed
    - View progress towards daily/weekly goals (visualized)
    - Edit Profile
    - Activity plan
    - Resources
    - Logout
- Edit Profile (Basic Information: first name, last name, username, e-mail, Language: Set preferred language, Caregivers: Add caregivers, Data providers: Enable data providers)
- Activity Plan
    - Create activity plan based on a predefined set of activity types, define intensity and duration. When the user is creating an activity plan, the user

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will receive updates on planned activity per week (intensity, duration) versus recommended physical activity (intensity, duration) by global health authorities. E.g. You have now planned 100 minutes high intensity training, you should add 50 minutes moderate intensity training this week to reach global guidelines on physical activity.

- Resources
  - A list of relevant publications (e.g. WHO publications)
- Notifications (configured via Rules Editor and Adaptation Engine).

For the secondary user (caregiver):

- User administration (register profile, log-in, administer profile, logoff)
- Analytics on the data gathered and analysed
- Possibility to receive alerts when goals are not met over time

The details about planned physical activity and exercise can be inserted by the user or by the caregiver. The personalization rules are edited through the authoring environment described in [4].

Integration with PersonAAL Context manager server
The physical rehabilitation server connects to the context manager server and sends events when the primary users has performed planned activities or changed goals (goal is reached, goal is changed, statistics at en of day). This allows other applications connected to the PersonAAL platform to use these events.

Integration with PersonAAL Adaptation module
The physical rehabilitation engine will apply personalization rules as defined in section 3 and additional rules identified through the project.

Integration with the Persuasion module
The application will be integrated with the Persuasion module, either directly or through the context engine.

Integration to the central authentication (OAuth) server
The application will be integrated to the central authentication (OAuth) server.

Context manager server username in User profile
The context server engine username value is used to map a auth0 user to a user defined in the context manager engineserver. This is a temporary solution until the context engine uses the auth0 username.

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2.4 Specifications

The application has a simple user interface for the elderlies to plan and track activity, and get notifications and alerts when goals are achieved or not.

The application extends and use the Fitbit device to measure activity (distance, active minutes, bpm). The application integrates with the PersonAAL platform sending event and activity data to the platform and receives events to notify user and help change behavior.

2.4.1 System context

The system context shows the main components the application interacts with.

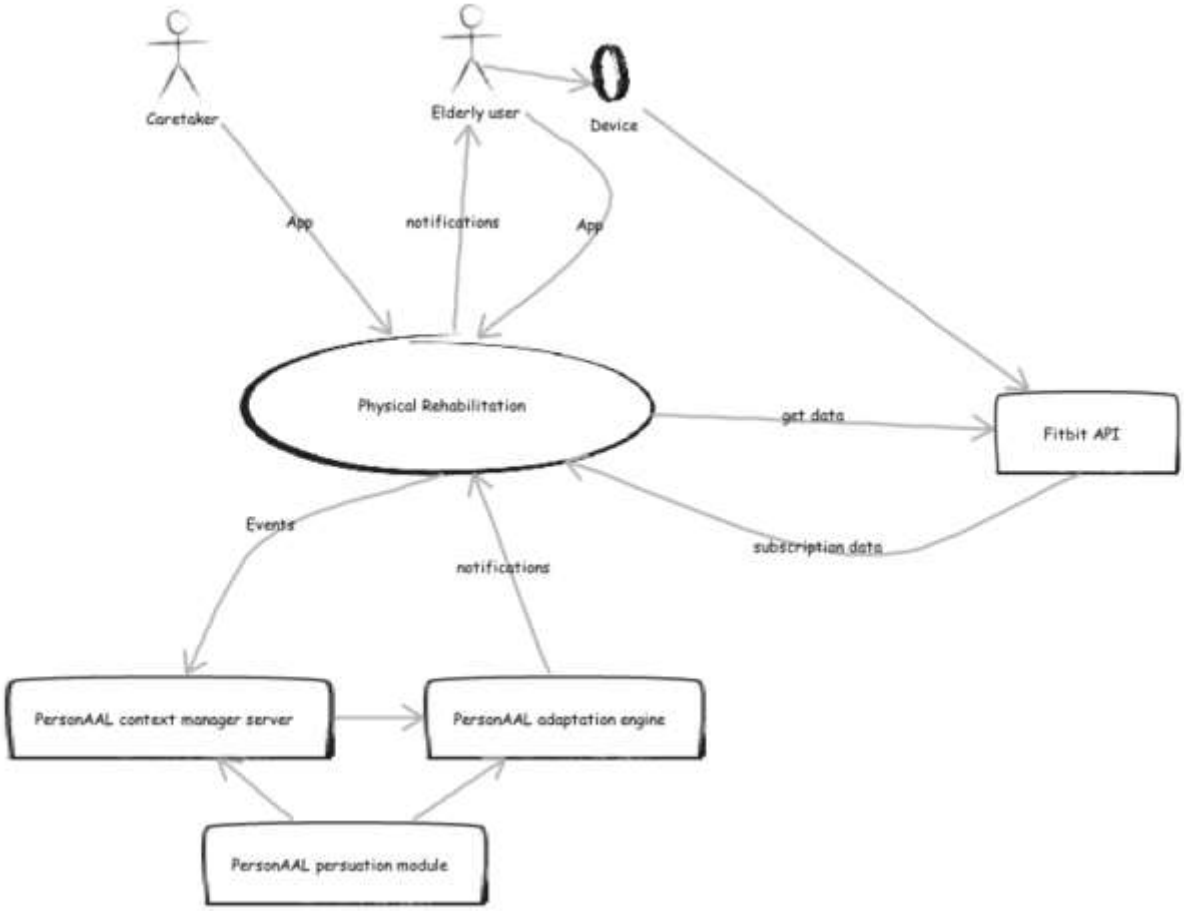

Figure 1 System Context for the Physical Rehabilitation Application

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2.4.2 Proposed architecture

This application will use the same architecture as the medication monitoring application.

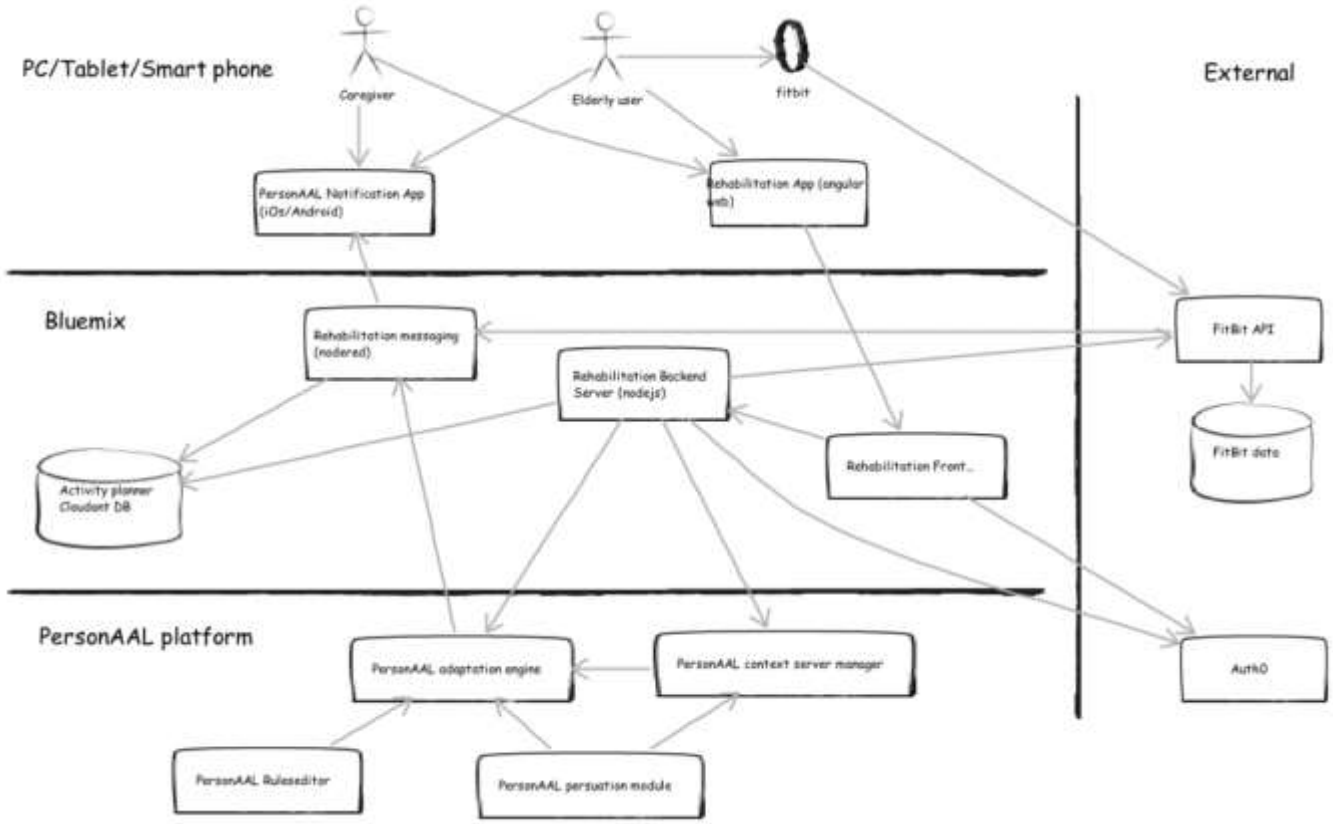

Figure 2 Architectural Overview for the pysical rehabilitation application

2.4.2.1 Frontend

The application will be a responsive webapp to be used on tablets /pad's, and other communication platforms. The infrastructure will include the following apps:

i. Physical Rehabilitation (PR) frontend webapp
ii. Physical Rehabilitation (PR) app (cordova based for android and iOS)

i. The PR frontend webapp and app; the user interface for an application that will allow elderly users with low or no computer literacy to use the application on a smart phone or tablet. This shows a very simplified progress for the goals set using

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the fitbit data retrieved from the FitBit API and progress bars for the number og minutes panned activities compared to performed activity.

ii. PersonAAL notification app: An app (Android and iOS) to be installed on tablet or smartphone. The app receives push notifications from the backend server when the user has planned physical activity and/or exercise. The app will interact with the frontend web app where the user can see the plan and register completed activity. The app is also used to send persuasion messages to the user from the Persuasion module.

2.4.2.2 Backend

The Physical Rehabilitatioin backend components consists of the following parts:

i. Physical Rehabilitation messaging (nodered)
ii. Physical Rehabilitation backend server
iii. Physical Rehabilitation Cloudant database

i. Rehabilitation messaging; this is a nodered application which handles message flows. This component is responsible for checking the Physical Rehabilitation database to find activities at a certain time that should be started and initiates sending a push notification to the PersonAAL Notifiction app. The component also acts as a Context Delegate sending "activity planned" events to the Context Manager server. This is done in the same flow as sending push notification to the notification app. The component also exposes a REST service that other PersonAAL components can use to send notifications to the notification app. This is used by the Persuasion component to send notifications to the user.

URL: https://ext-nodered-personaal.eu-gb.mybluemix.net/sendPushMessage
Type: POST
Payload: {"username", "message"}

ii. The PR backend is developed in node.js and runs on a cloud foundry or docker container environment. During the project, the application server runs on the Bluemix cloud platform. The backend server uses a Cloudant database and a DashDb database provisioned via the Bluemix platform. Both databases store data encrypted. The backend server communicates with the PersonAAL platform components Context Manager Server and Adaptation Engine through REST service calls.

iii. Cloudant database running on Bluemix. The database is encrypted.

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2.4.3 Key features

2.4.3.1 Login

The login page shows the PersonAAL authentication service logon and signup capabilities. If the user is not already registered as a PersonAAL user the user must register using the "Sign Up" feature. This creates a user in the PersonAAL user registry. Before the user can access any PersonAAL application the user must verify their email used for registering. After the user is registered the user must create their userprofile for the Physical Rehabilitation application.

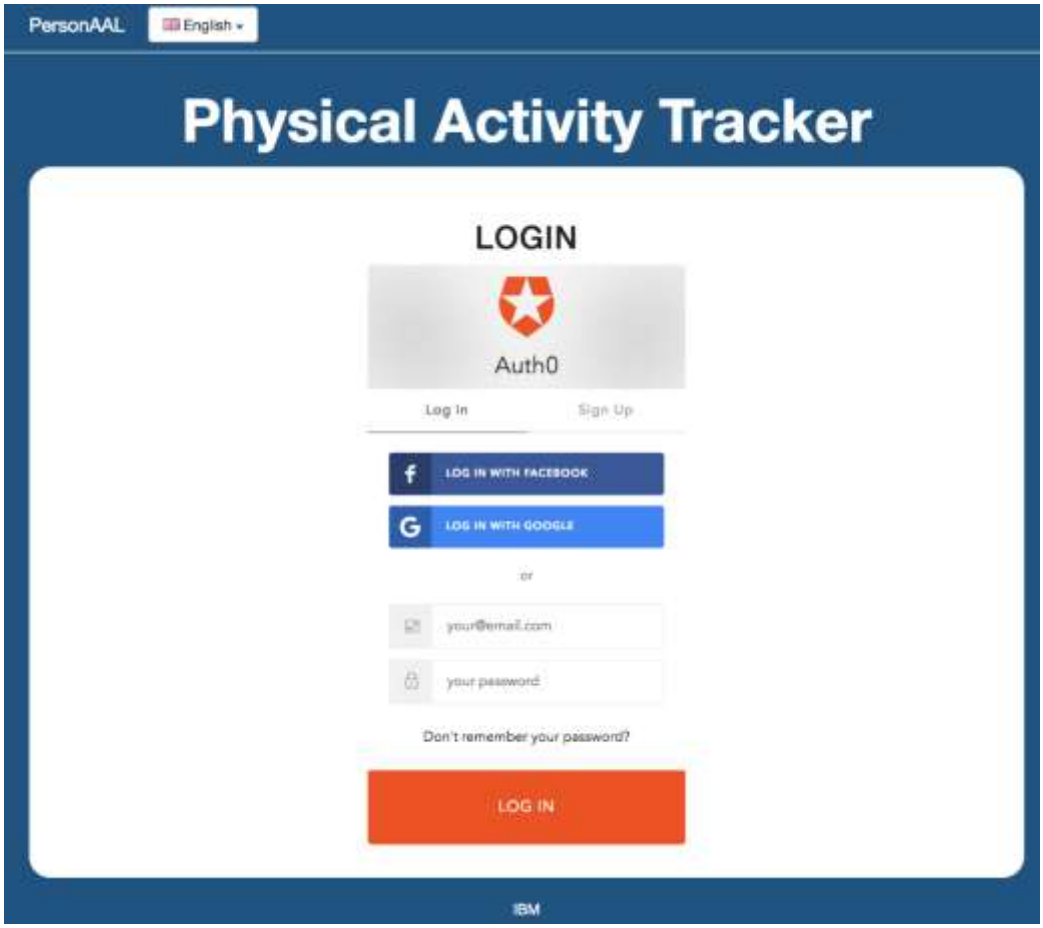

Figure 3 Login screen

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2.4.3.2 User profile

This page allows the primary user or the caregiver to update a profile for the application. The user has to verify him/herself with Auth0 before finishing the registration progress.

The following information must be provided when registering a profile:
- Basic Information (First name, Last name, User name, E-mail, contextengine username)
- Language (Preferred Language)
- Caregivers (Add caregivers).

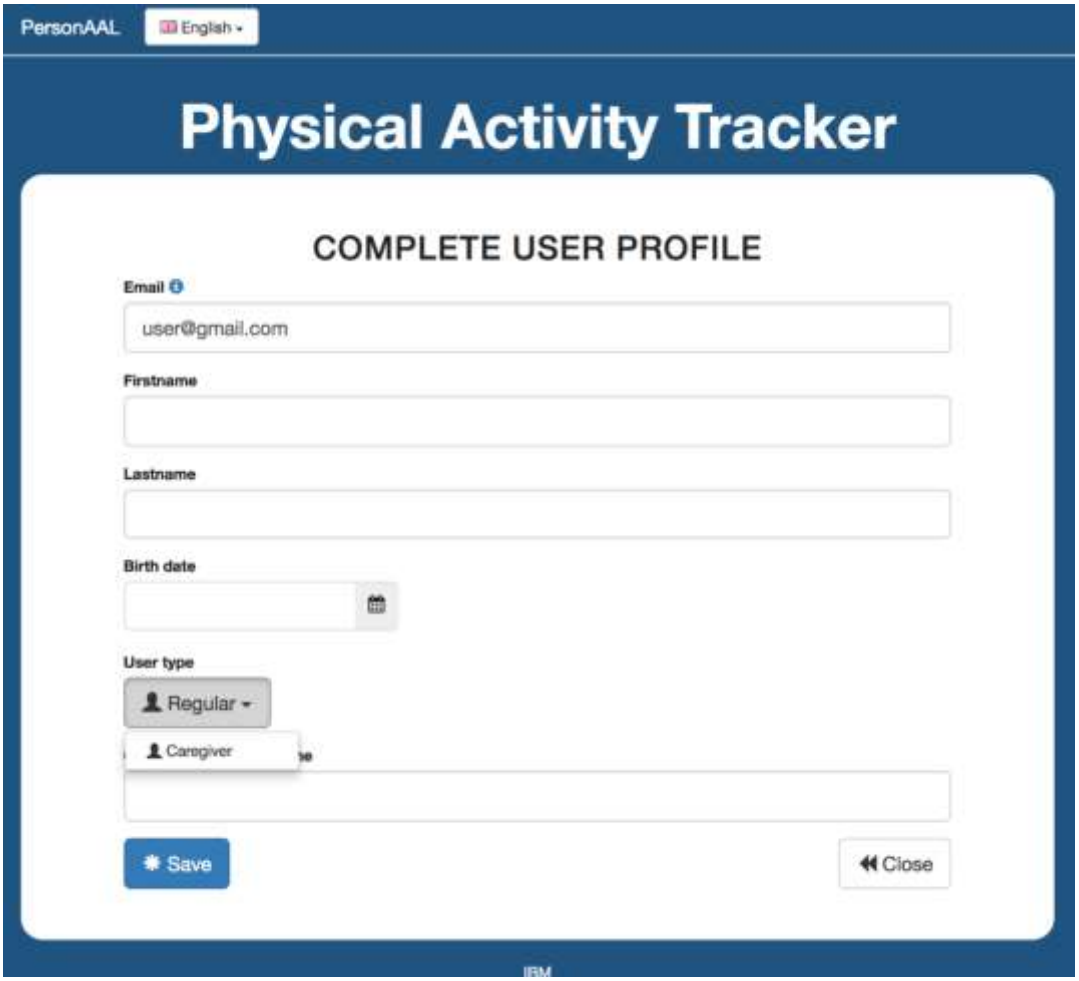

Figure 4 Complete user profile screen

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Figure 5 Verify email information

The **context manager server username** should be the same username as used in the PersonAAL rules editor and context management server. This is used until the context manager server uses the Auth0 username. This username is used when communicating with the personaal platform components.

In the Basic information tab the user can change their First name and Last name. Email adress and username can not be changed here as it is linked to the Auth0 user account.

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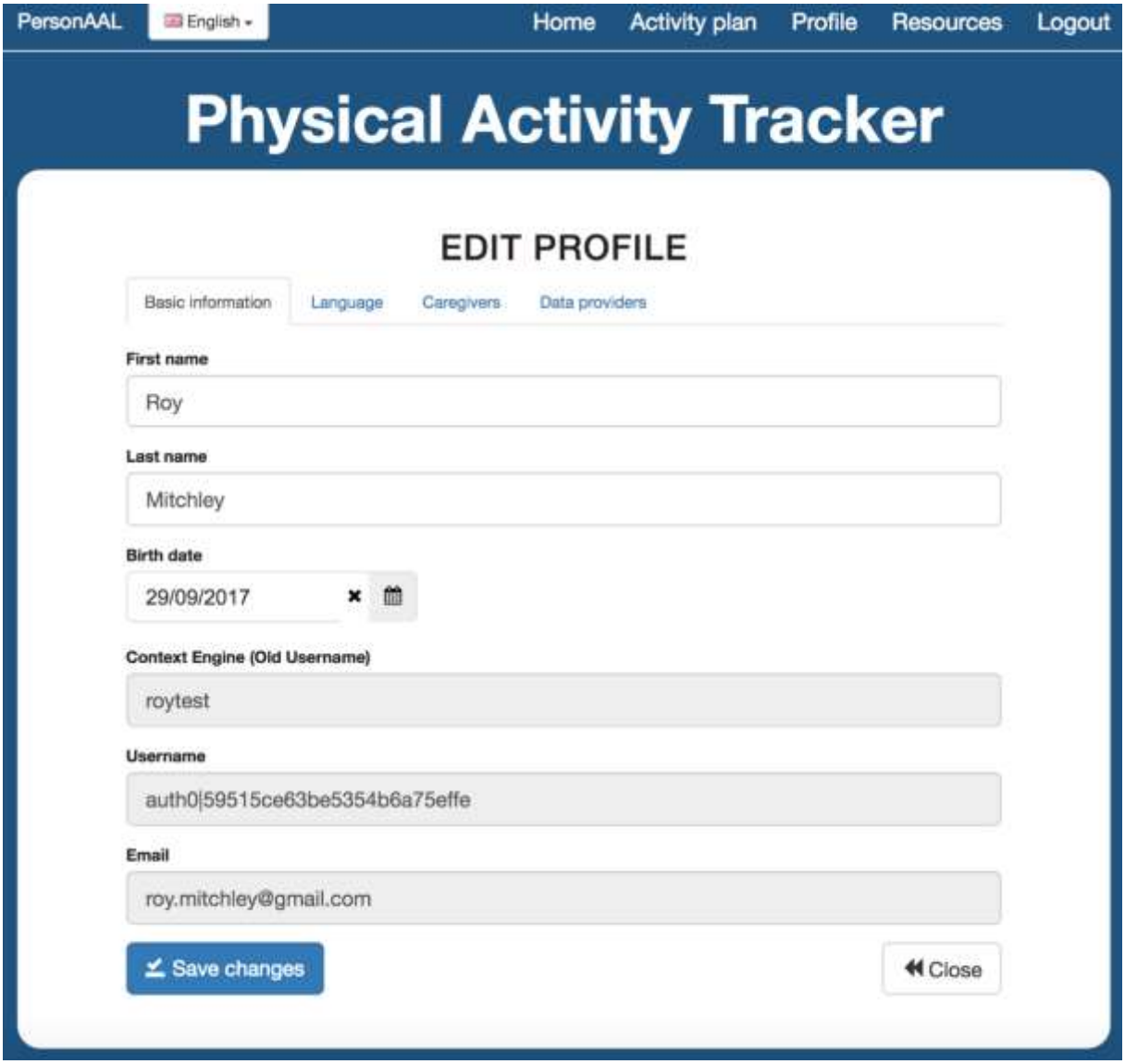

Figure 6 Edit profile – Basic information

On the Language tab the user can select a default language. This will be the language used when the user logs on. The user can change language using the language selector in the top menu.

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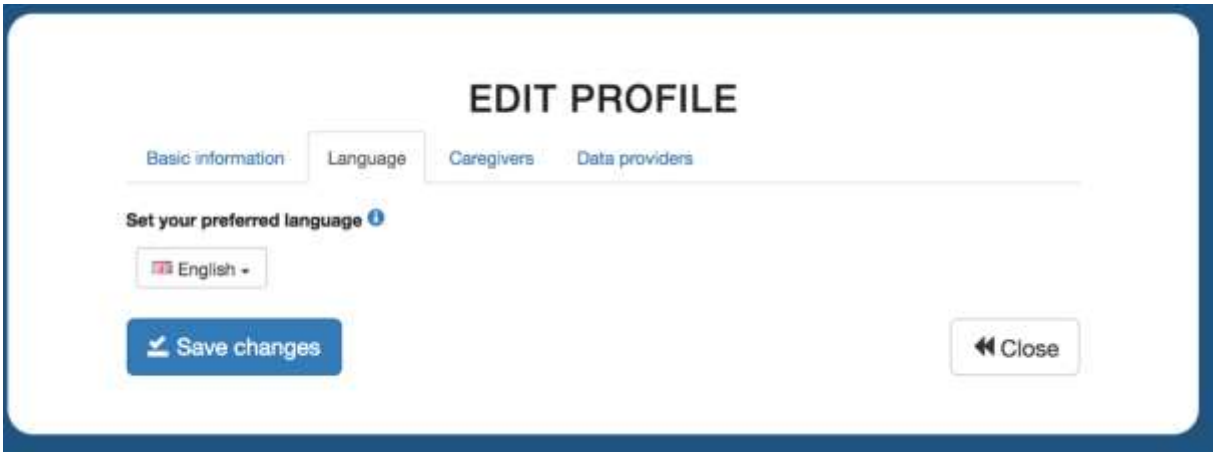

Figure 7 Edit profile - Language

In the caregiver tab the user can add caregivers that should have access to his/her activity plan.

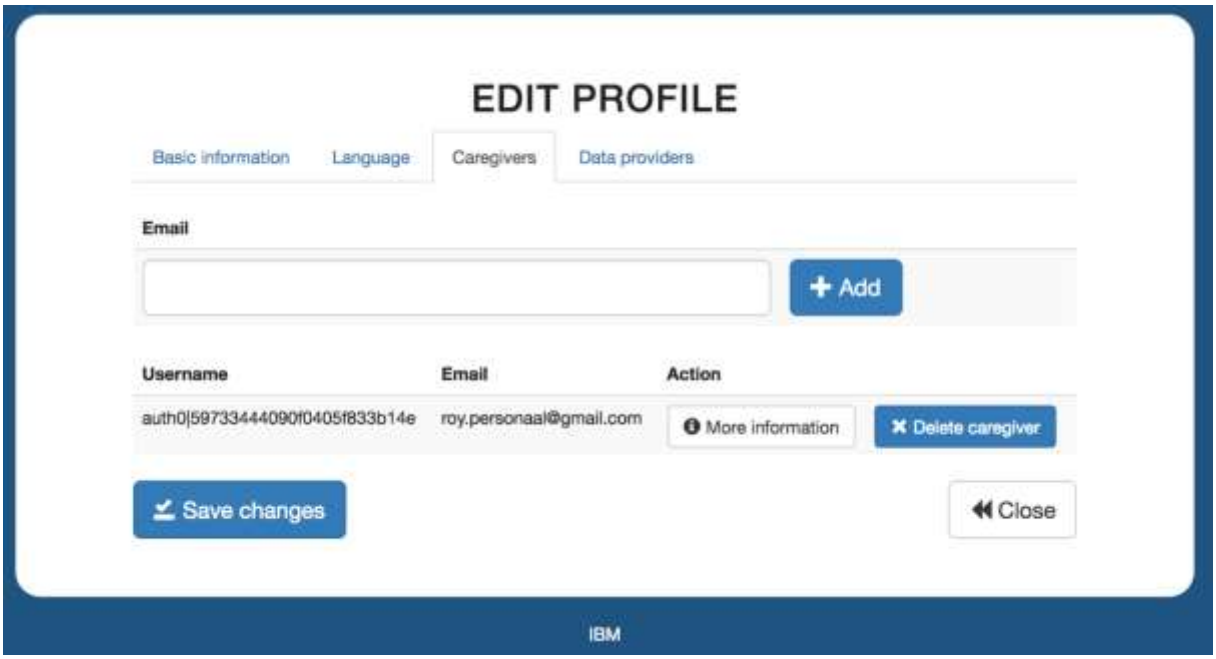

Figure 8 Edit profile – Caregiver

To add a caregiver the user enters the email for the caregiver and clicks the "Add" button. The system will only add the caregiver if he/she is already registered in the application with a user type = "caregiver". See Figure 4.

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Figure 9 Edit profile – Data providers

This is the page where the user can connect their fitbit account to the application so activity data is made available to the application and the personAAL platform components.

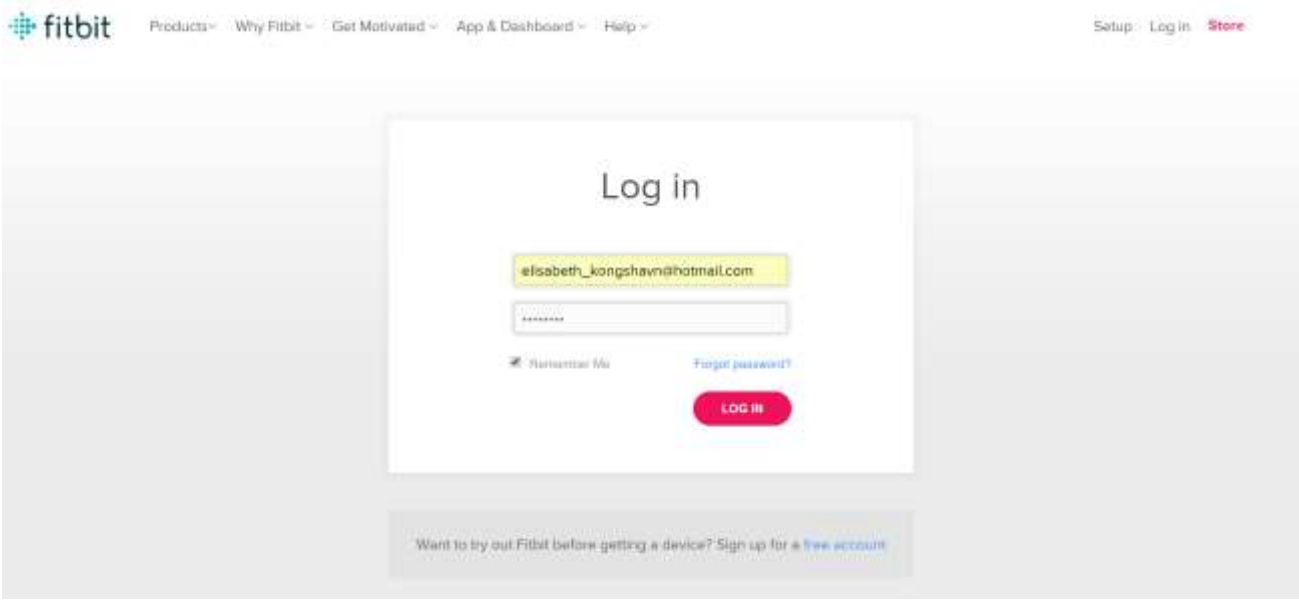

Figure 10 Login fitbit screen

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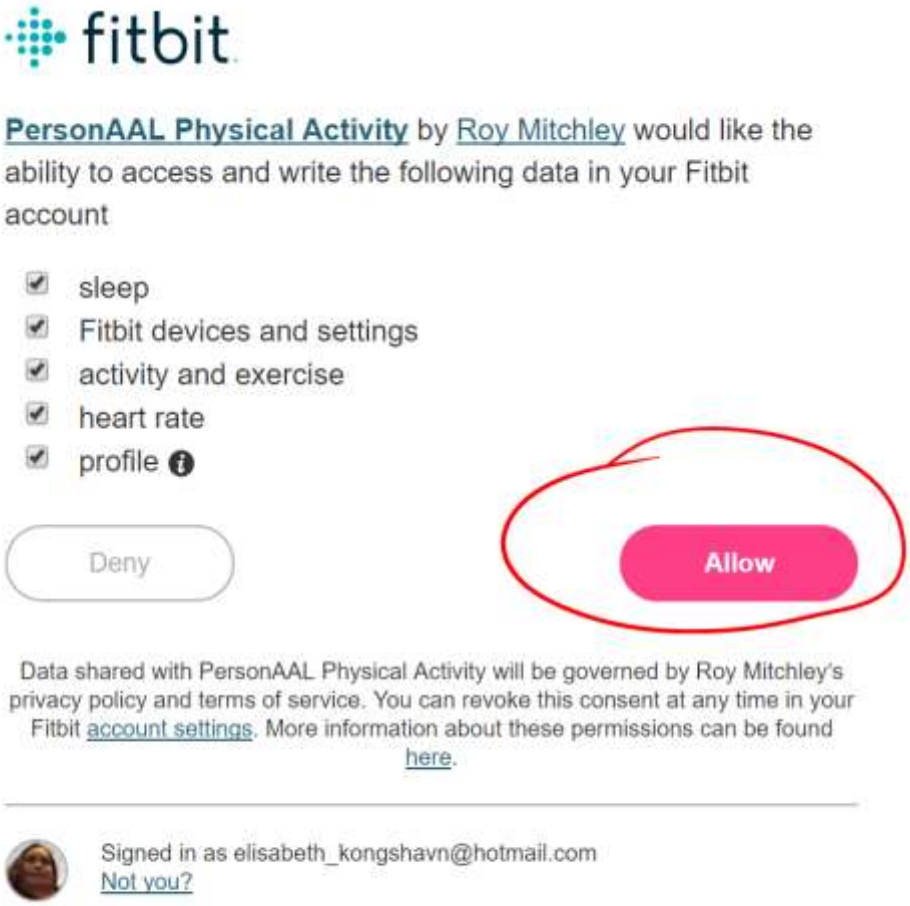

Figure 11 Allow fitbit screen

2.4.3.3 Home

This page welcomes the user and provide an overview and summary of the current activity completed today.

Through the homepage the user can access and administer:

- Profile (Basic Information: first name, last name, username, e-mail, Language: Set preferred language, Caregivers: Add caregivers, Data providers: Enable data providers)
- My Activity plan (goals versus actual activity for the current day/week)

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- Self-reporting of completed activities
- Access to Activity Plan, Statistics, Resources and Edit Profile
- Log-out

Figure 12 Home screen

From the home screen the user can see his progress on steps and floors from fitbit data and progress on duration completed activity (high intensity and medium intensity).

When the activity has been completed the user can mark this as done by clicking the "Mark done". A dialog box is presented where the user can change the time completed and adjust the duration spent if this is not as planned.

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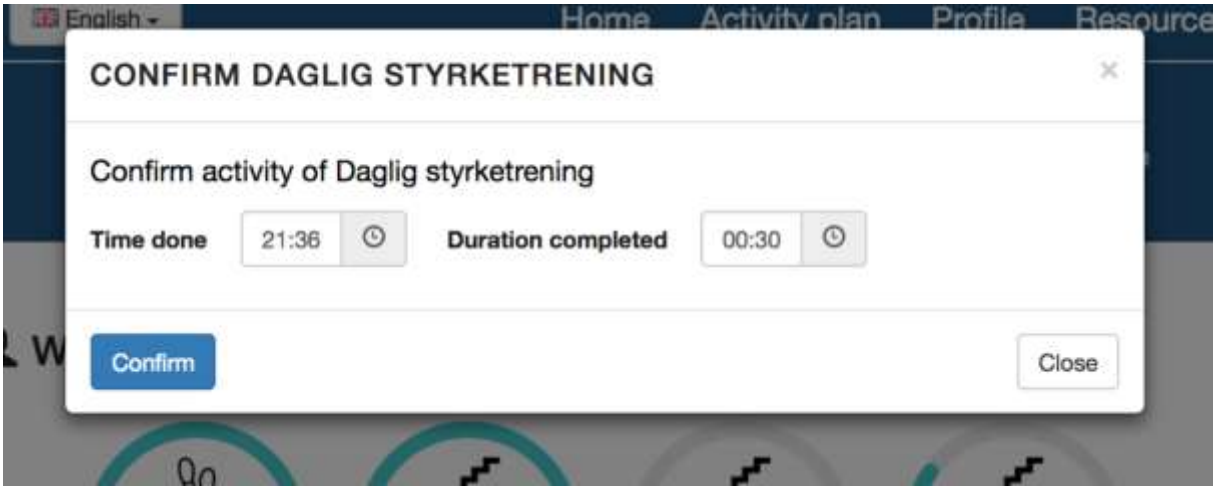

Figure 13 "Mark done" dialog

The user can also add a note to the activity log. This is done by clicking the "Add log". The user can also choose to mark the activity as completed at the same time. This is done by "Mark done". The Time done and Duration completed are then activated so the user can make adjustment.

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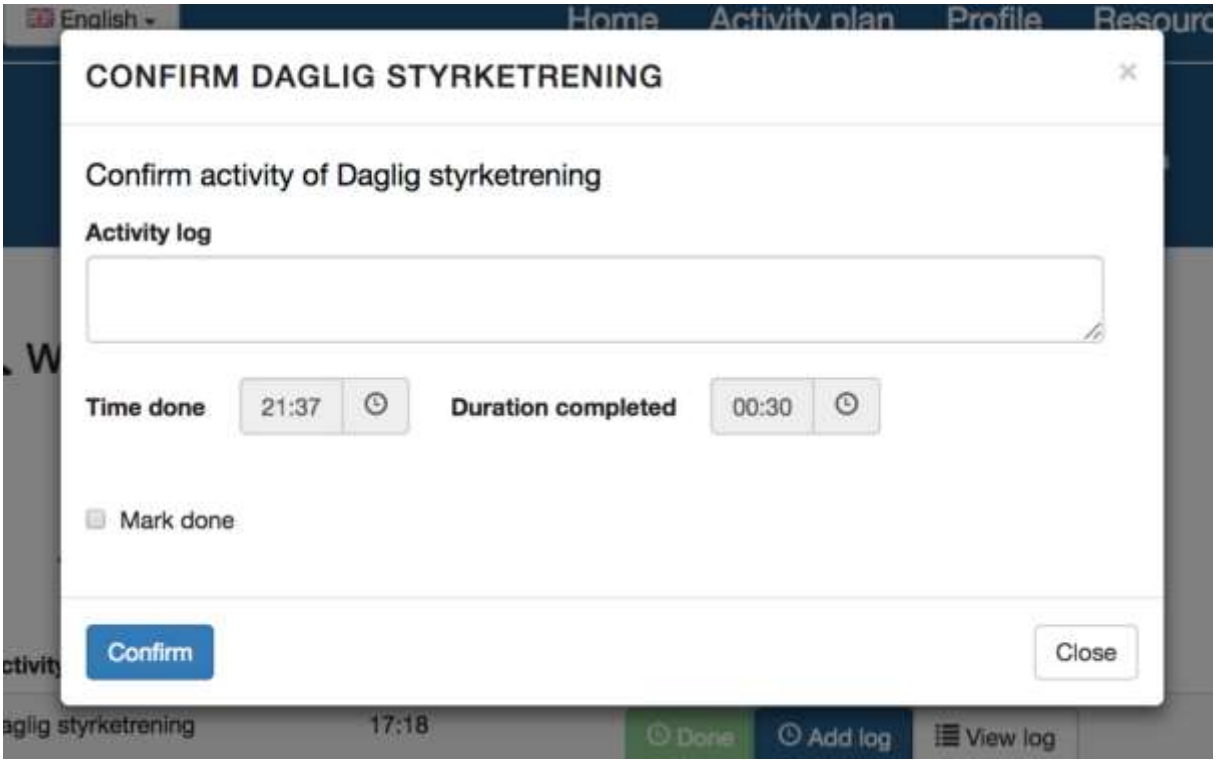

Figure 14 "Add log" dialog

The user can also view the log entries by clicking the "view log" button. The user can also remove log entires or make updates from the view log dialog.

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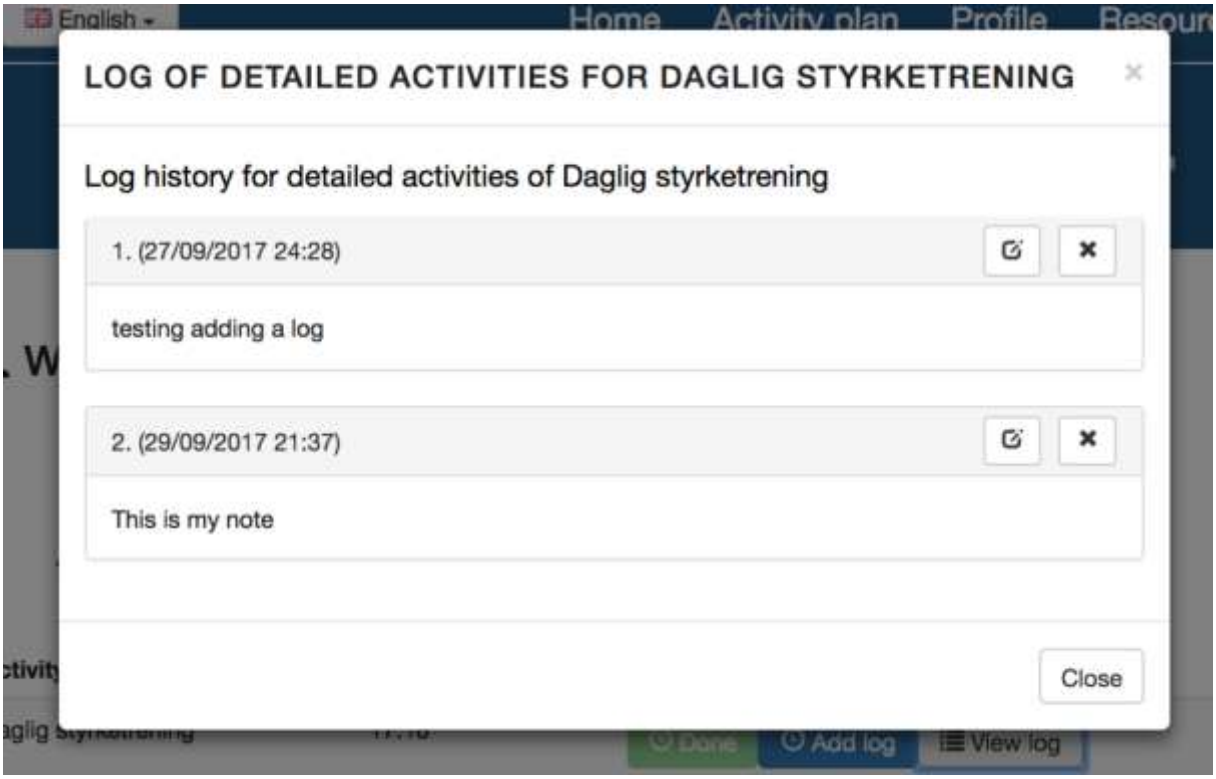

Figure 15 "View log" dialog

2.4.3.4 My activity plan

This is the page where more detailed daily activity is registered by the user.

All-day activity, including

- Add weekly goals for exercise and activity in minutes (walk, dance, exercise, swim, housework, play with grandchildren, strength and balance excercises) based on guidelines from national health auhtorities [6]/[7]/[8]. The user must specify type of activity, intensity (high or moderate) and planned duration.
- Link to the the national guidelines for physical exercise and activity where the user can explore recommended type of activity, recommended time/day, examples of exercises (balance and strenght) etc. [6]/[7]/[8].
- View progress towards daily goals (walk, dance, exercise, swim, housework, play with grandchildren, strength and balance excersises)
- See trends over time

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Figure 16 Activity plan

Here the user can add and update activities for the activity plan.

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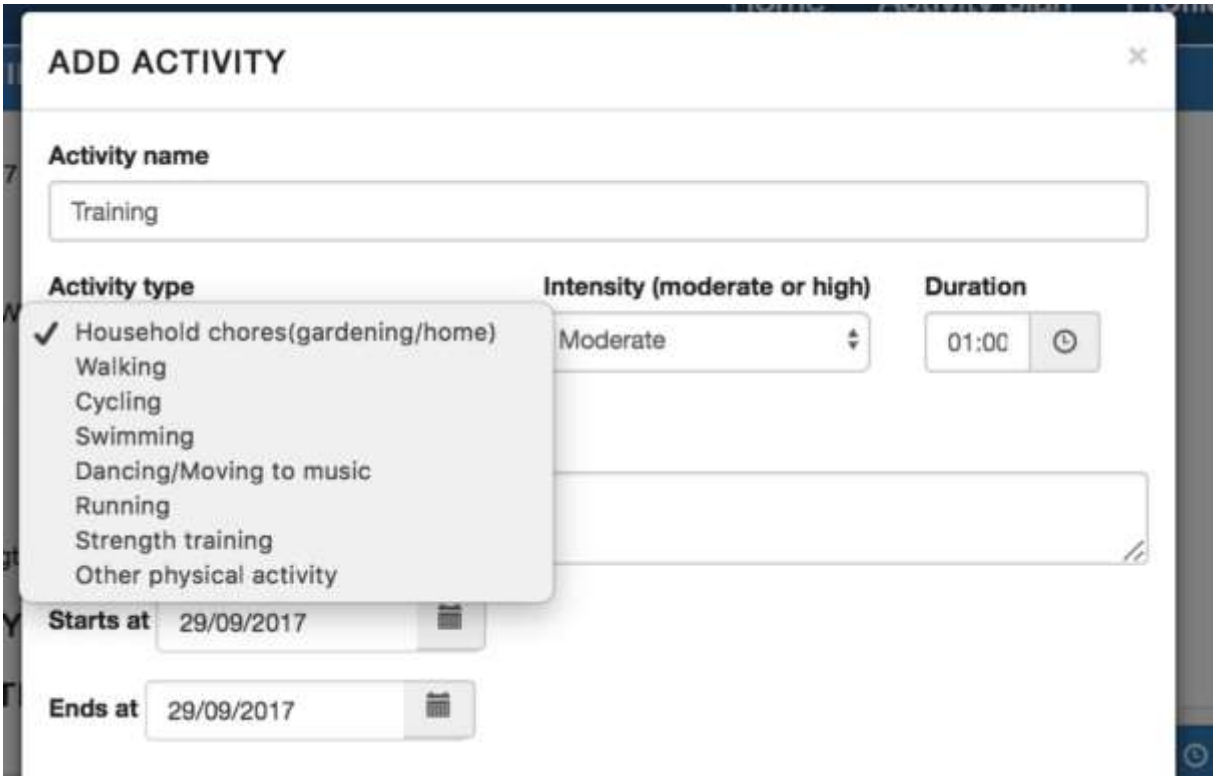

Figure 17 Activity plan – add activity

When the user selects "Strength training" the user gets additional option to add predefined exercises.

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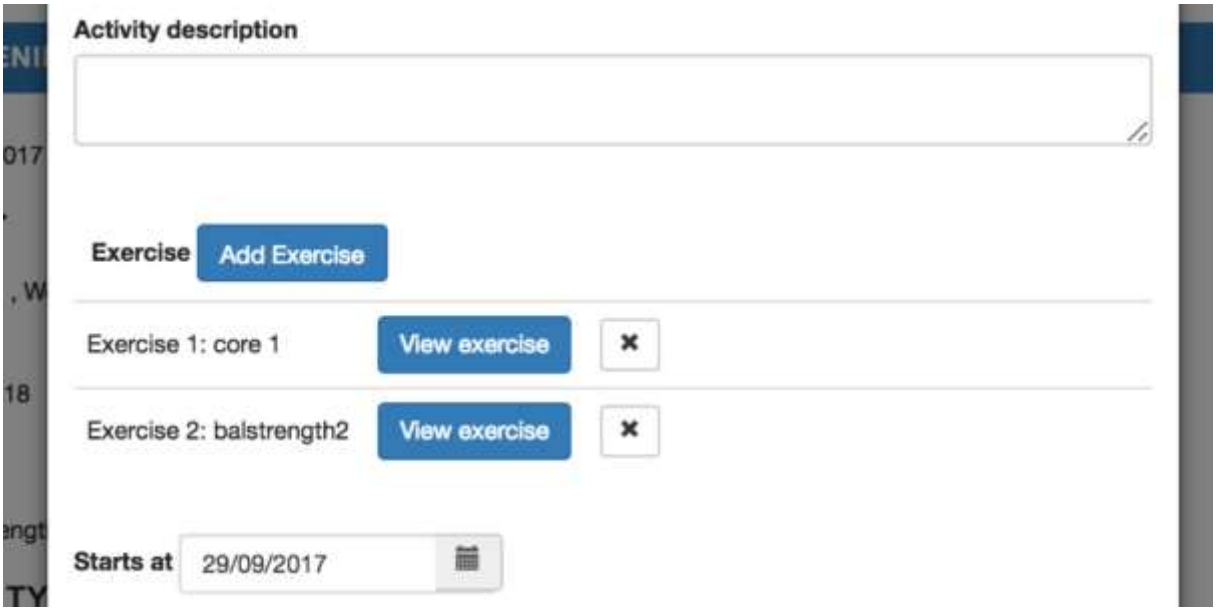

Figure 18 Activity plan – "Strength Training" Exercises

When the user clicks "Add Exercise" a modal window is opened where the user can select from a set of predefines excercise descriptions and visualizations.

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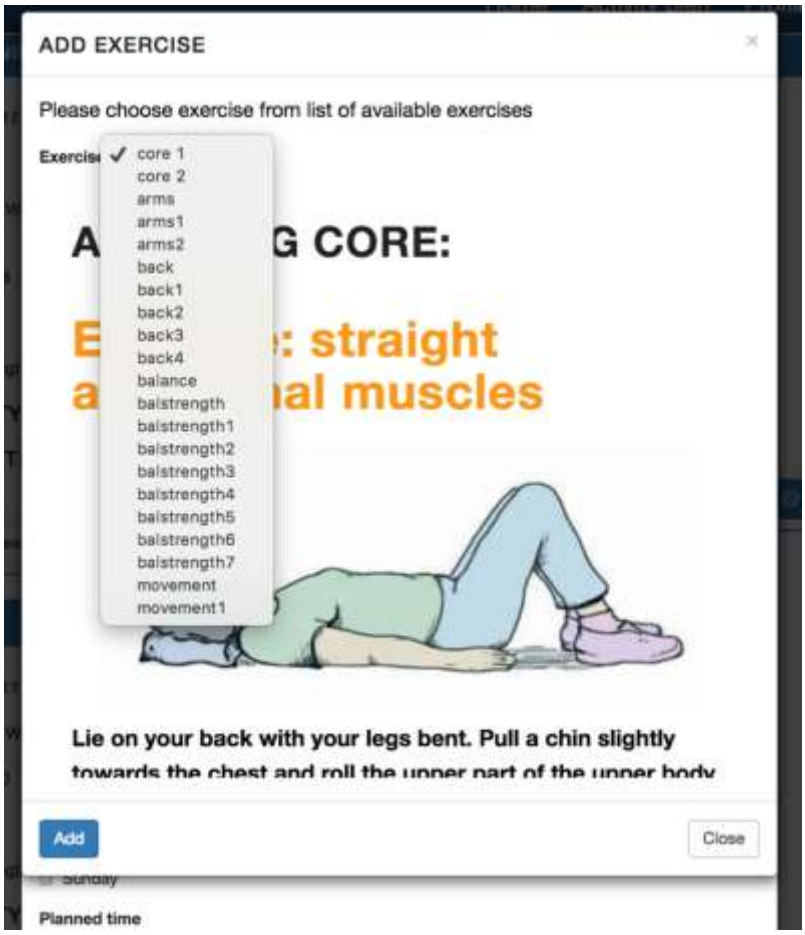

Figure 19 Activity plan – Add exercises

When the user just wants to see how the excercise is performed he can use the "View excercise".

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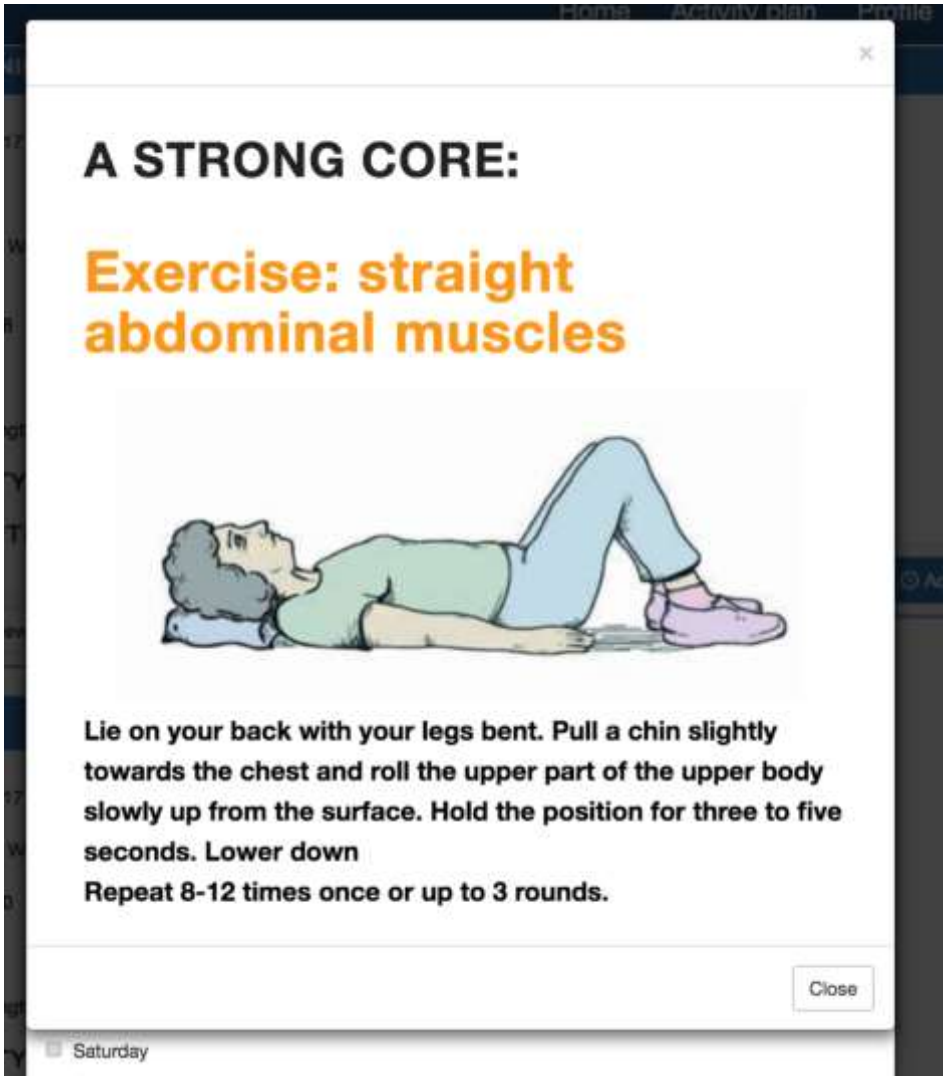

Figure 20 Activity plan – View exercise

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2.4.3.5 Notification

- Notification/alert to charge battery when battery is running low
- Notification/alert when goals are reached / not reached
- Notification/alert to caregiver when goals are not met over time

2.4.3.6 Enable fitbit data integration

To enable tracking of physical activity data together with the activities the user performes, the user can allow the rehabilitation application to get data from other activity tracking devices. Currently the Fitbit is supported in addition to the Plux sensors that share data through the PersonAAL Context server manager. To enable this integration the user has to connect their fitbit account to their Rehabilitation user profile. This is done in the Profile page in the tab Data providers. See screen details below in section User interface and Figure 16. The Plux sensors do not need to be configured in the user profile.

Once the user has connected their user profile to their fitbit account the app will show progress on steps and floors in the home screen. The progress data will also be used to create rules and notifiations to the user to help persuai the user to complete their activity plan.

Figure 21 Edit profile – Data providers

This is the page where the user can connect their fitbit account to the application so activity data is made available to the application and the personAAL platform components.

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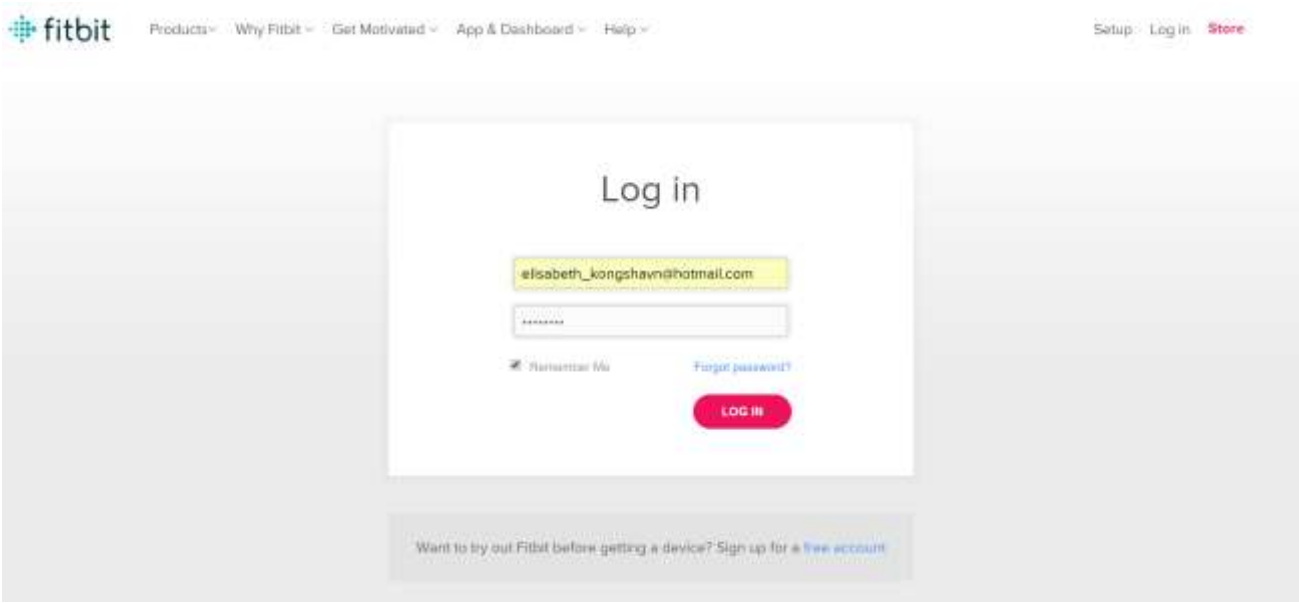

Figure 22 Login fitbit screen

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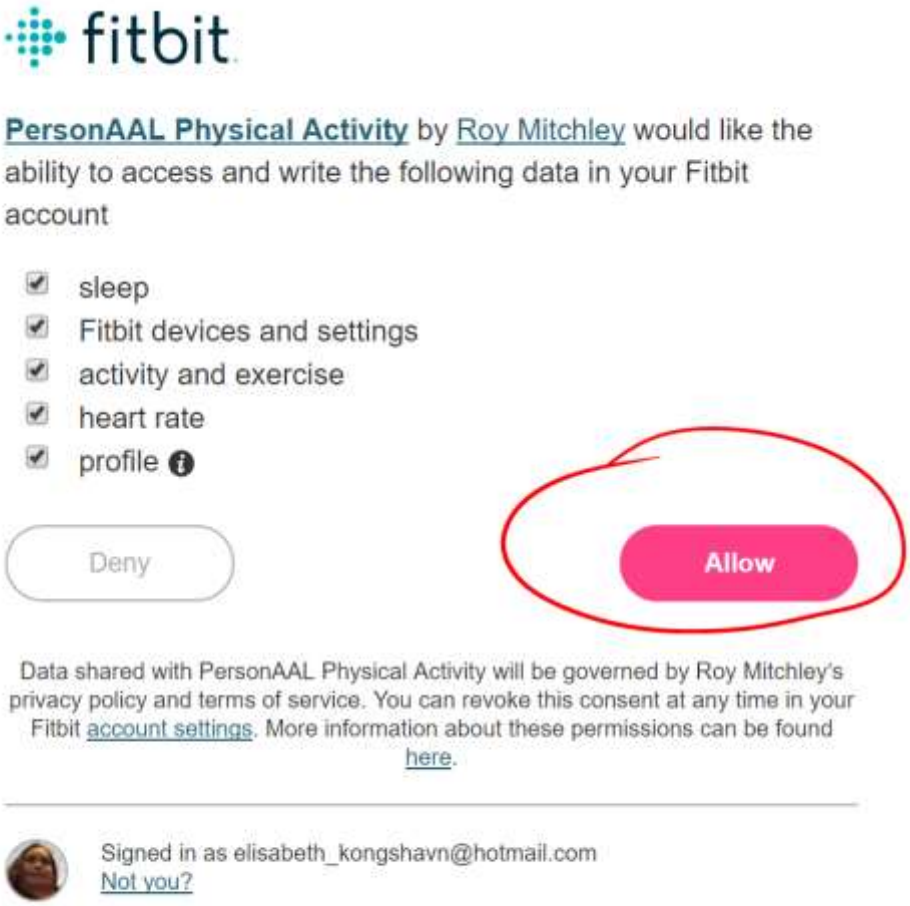

Figure 23 Allow fitbit screen

2.4.3.7 Caregiver

To add a caregiver, the caregiver must first register as a user. This is done by selecting "Sign up" in the Auth0 sign-in.

After the user is created in Auth0 the user is presented with a page to create a user profile for the application. When registering the user profile, the user type "Caregiver"

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needs to be selected. After the userprofile is created the user also needs to verify their email before they are allowed to login.

Now the users can add the caregiver to their userprofile to allow the caregiver access to their data.

The user logs on and opens their Profile. There they select the Caregiver tab and search for the caregiver user (Caregiver's e-mail), and add the selected caregiver e-mail.

When the caregiver logs on in the home page, the caregiver is presented with a list of users he/she has been given access to. When selecting a user, the caregiver gets access to all the users data and can help create and administer the activity plan for the users.

Figure 24 Caregiver home screen

When the caregiver selects the user to view or help create the activity plan he / she gets the same view as the user, but has a green button on the top bar to go back to the caregiver home screen. For security, all changes the caregiver does to a user's data is traced in the database with the caregiver userid.

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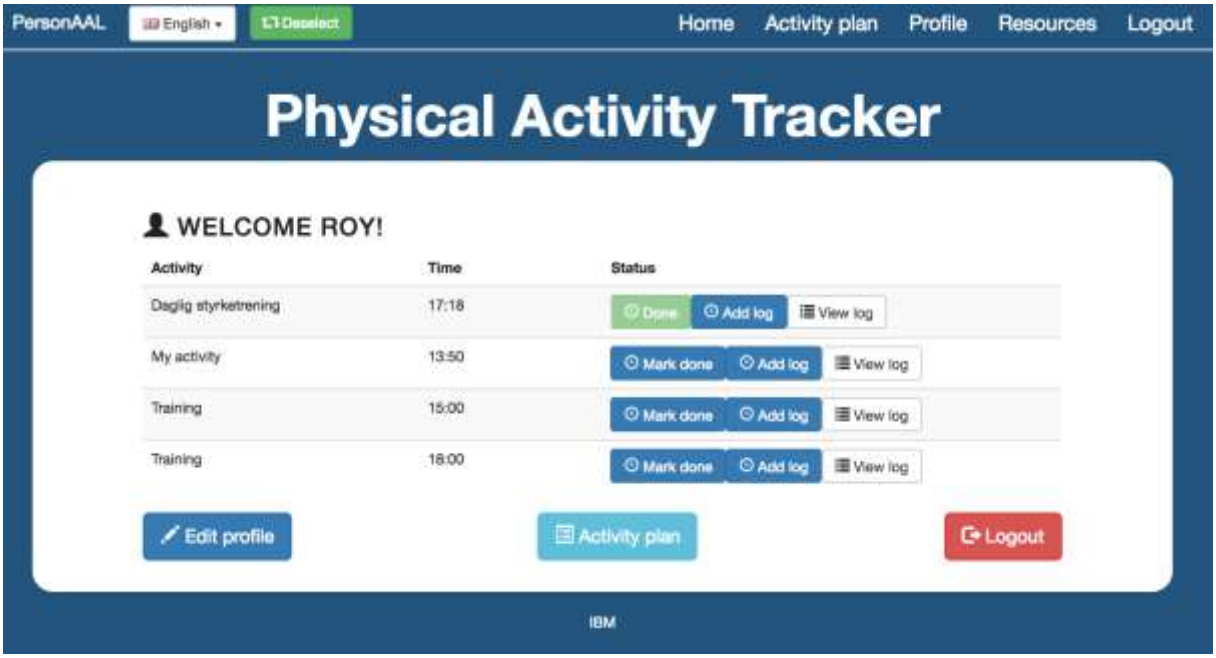

Figure 25 Caregiver – Home screen of user

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3 PERSONALISATION

This section describes how we use the PersonAAL Platform [1] to provide the user with personalized assistance, customized on his/her individual needs, requirements and characteristics through the specification of trigger-action rules ([12][13]).

3.1 Trigger-Action Rules

For this application we identify an initial set of trigger-action personalization rules, listed below and grouped in four main categories. In futures releases more rules could be added depending on the end-user feedback.

3.1.1 Improve page readability depending on user characteristics and surrounding environment.

- IF Age is more than 70 AND Light Level is less dimmed, DO Change Font Size to 18px and contrast
- IF Light Level is less than 5, DO Change Background Color
- IF View Ability is colour blind, Do Change Font Color

3.1.2 Send personalized reminders to user.

- IF User did not reach goals yesterday, DO send a persuasion by notification?

3.1.3 Send alerts to caregiver if user behavior appears not normal.

- IF activity is declining during a set period, DO Send notification

3.2 Context detection/engine

The physical rehabilitation application has a context delegate component that sends data to the context manager server when an activity is planned (entity: activity_planned) and when the user registers to have completed the activity (entity: activity_occured). At the end of the day statistics for the full day is sent to the context manager server.

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4 FIELD TRIAL PLAN

4.1 Objectives and measurements

The field trial plan will be conducted jointly for the platform and for the three applications, with the objective to measure:

- User acceptance and comfort level: collected through questionnaires: comfort level, perception of being controlled or in control, perception of added value, security of information, limited installation and maintenance required at the consumers house, usability comparison with/without personalization, persuasion/behaviour analysis.
- User activity: involves mainly measurements: usage time, event logging (use of different functionalities, number of rules, and number of errors).
- Social support effectiveness: The feedback will be collected both in Switzerland and in Norway, ideally involving 8-12 users in each site.

4.2 Requirements

4.2.1 End users

The end users will be required to use the application and the Fitbit device in their homes for a period of time sufficient to gather useful information. They should then:

- Be available for 6-8 weeks testing in house.
- Be available to wear the sensor chestband at least once a week for the health check and while doing their exercises.

The personal information will be collected through web forms and sensors according with the best current security and privacy practices, will be anonymized where possible and stored only for the time required to provide the service.

Before enrolling in the field trial, participants will be informed of all aspects that are relevant to the subject's decision to participate and will be required to sign a written informed consent according to guidelines from the fields of medical ethics and research ethics. Moreover, they will be allowed to dropout at any time if they wish to.

4.2.2 Hardware requirements

In order to test the Physical Rehabiliation application, the hardware required is as follows:

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- Laptop PC with internet browser and Android Tablet or Android phone 3G, WiFi and Bluetooth, to access the Nofitifcation App and Web application.
- Fitbit device and fitbit account

4.3 Timeline

The hypothesis and ideas driving the plan are listed below:

- Field test will last from 1 Oct ’17 to 30 Set ’18.
- Allow 3 months (Oct – Dec ’17) for for application rework after Usability and Accessibility tests completion, integration and on site preparation.
- Leave 3 weeks for application rework after Usability and Accessibility tests completion (and then start on third week of October)
- Leave 2 months (August and September ’18) for analysis of results and implementation of final version of application.
- Each user should test for at least 6 weeks
- Involve 8-12 users per site (Switzerland and Norway)
- Consider having 4 full set of hardware equipment (based on the costs).
- Allow some rework time to improve the applications and platform between the different test sessions.

We plan three rounds of tests:

- First round with friendly users, focusing on User acceptance and Comfort level. The users will be required to fill a (for example) weekly feedback form reporting their experience.

- Second round focusing on User activity. The user access to the different functionalities of application will be logged and analyzed. We will anyway focus on qualitative analysis as we don’t have the numbers for statistical analysis.

- Third round focusing on Social activity. In order to have more testers and to evaluate the social activity there could be some users with full equipment and others only subscribing to the application.

Site	Nov ’17	Dec ’17	Jan ’18	Feb ’18	Mar ’18	Apr ’18	May ’18	Jun ’18	Jul ’18	Aug ’18	Set ’18
			User Satisfaction		Usage/Effectiveness			Usage/Effectiveness (social activity/persuasion)			
CH	Preparation work		2 users		2 users		2 users	2 users with full equipment + up to 4 with partial equipment			
NOR	Preparation work		2 users		2 users		2 users	2 users with full equipment + up to 4 with partial equipment			
Results analysis											

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and Rework											
App version			2.1		2.2			2.3			3.0

Figure 26 Field Trial Plan

The application will evolve as follows during the third year of the project:

V2.1:

- Incorporate the feedbacks from Usability and Accessibility evaluation;
- Enhance integration with other PersonAAL modules.

V2.2:

- Integrates the recommendations from the User Acceptance and Comfort Level test round;
- Incorporates behavior analysis;
- Extend the application with cognitive capabilities using IBM Watson technologies, e.g a user can communicate with system using natural language and voice for select languages.

V2.3:

- Integrates the recommendations from the User Activity test round;
- Further extentions

V3.0:

- Final version of the application

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5 CONCLUSIONS AND FURTHER DEVELOPMENT

This document describes the physical rehabilitation demonstrator and how the application will be integrated to the PersonAAL platform.

Additional functionality to be included in future versions of the demonstrator could be:

- Analytics functionality, including statistics and reports to the primary and/or the secondary user that shows adherence to activity plan and global recommentations on physical activity and exercise.
- Watson Chatbot, a cognitive add-on where Watson can talk directly to the elderly users of the application. Watson Chatbot uses machine learning, and can be learned to answer many questions [15].

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