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FIT4WORK

SELF-MANAGEMENT OF PHYSICAL AND MENTAL FITNESS OF OLDER WORKERS

CO-FUNDED BY

PARTNERS

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Mental stress relief exercises

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1 Introduction

One of the goals of the Fit4Work system is to detect mental stress occurrence and to propose relevant strategies to reduce the impact of it on the user's life. The solution for this are guided stress relief exercises designed to reduce person's mental stress. Prolonged high levels of stress are well-known to have adverse health effects. Fit4Work's monitoring algorithms endeavor to detect such circumstances and offer practical ways of countering chronic stress. Mental stress relief exercises implemented by Fit4Work are based on established meditation practices, such as mindfulness meditation. They have been divided into two groups – breathing exercises and muscle relaxation exercises, alleviating both mental and physical tension caused by stress.

In this document we discuss the theoretical basis leading to the selection of specific mental stress relief exercises (see Section 2) and present how we implemented them within the Fit4Work system as part of the initial system prototype (see Section 3) and final prototype (see Section 4). Section 2 and 3 stand for the contents of deliverable 4.4.1, while Section 4 is the deliverable 4.4.2. It should be noted that some further improvements and updates have been added after releasing version 1 of deliverable 4.4.2 – the details of these changes have also been included as part of the final porotype and this document.

2 Stress relief exercises

Fit4Work aims to improve the lifestyle of elderly workers and in order to do that, the developed system monitors users' physical activity, mental stress and the ambient conditions at the workplace. This deliverable is focused on describing stress relief exercises as part of the mental stress monitoring and relief.

Muscle relaxation and breathing techniques are considered to be parts of the clinical psychology domain, but they can be learned and applied in other psychology branches, and in everyday life. Experimental research has allowed evaluation of the most effective relaxation exercises that can be obtained with these methods. Almost all structured relaxation methods used nowadays, in professional activity and also in scientific research, are based on two techniques developed early 20th century: Progressive Muscular Relaxation (PMR) (Jacobson, E., 1938) and Autogenous Training (AT) (Schultz, JH., 1932). Both techniques are complementary, because each of them focuses on one of the main relaxation functions: muscular tone lowering with PMR, and suggestion and mental control with AT.

Relaxation focuses on the general activation reduction of the organism, which leads to two effects:

- Reduction of negative thought load
- Reduction of negative effects on health

Relaxation as an activation excess reduction procedure, doesn´t stick to the pure physiological dimension, but also to the other two relevant emotional dimensions: cognitive processes and the observable conduct (Fernández-Abascal, 1997). With respect to the physiological dimension, the effects of the relaxation are opposite to those of the sympathetic activation. This way, at the physiological level the relaxation produces a lowering of the following parameters:

- Tonic muscular tension
- Heart rate and hear beat intensity
- Adrenaline and noradrenaline secretion
- Arterial vasodilation
- Breathing patterns changes (frequency lowering, intensity increasing, breathing rate regulation)
- Basal metabolism
- Cholesterol and monounsaturated-fats
- Electrodermic activity

We introduced breathing exercises and progressive muscle relaxation exercises in Fit4Work. In order to work in stress lowering, which is one of the goals of our project, those two control techniques have been selected. They are powerful enough to achieve lowering of stress levels and also easy enough to perform, so any person can practice them easily.

Both techniques control the activation of the body and produce a positive effect at a physiological level, but they are also effective at a subjective level, that is, the person perceives themselves in a calm state afterwards, and their response to stress lowers considerably (Davidson, R.J. & Schwartz, G.E., 1976; Lehrer, P.M. & Woolfolk, R.L., 1993; Lehrer, P.M. & Carr, R.E., et al, 1997; Peveler, R.C. & Johnston, D.W., 1986).

2.1 Breathing exercises

Lungs are passive organs and thus for breathing contraction and expansion the performance of involved muscles is essential. Intercostal muscles expand the ribcage and they pull on the lungs forwards, while diaphragm pulls the lungs downwards. Diaphragm performance is very important because of the increase in the air volume it causes. An adequate breathing requires good muscular performance from both these muscle groups, in order for the person to use their full lungs capacity. Increased lung ventilation, in turn, improves oxygen contribution needed for the correct performance of the body.

Several conditions may lead to inadequate breathing habits. Certain stances, activities and situations, especially stressful ones, may lead to inadequate breathing patterns. One of the most recognizable stress and general physiological activation effects is the presence of quick and superficial breathing, which causes a reduced use of the lung capacity, worse oxygenation, more work for the cardiovascular system, a higher organic use and an increase in the general tension sensation of the body.

Below, some basic patterns and considerations about the way of performing breathing exercises are presented.

At the beginning of each exercise, the person should establish some conditions that facilitate it:

- Assume a comfortable position: standing up or sitting
- Close their eyes
- Wear comfortable, loose clothes
- Eliminate possible distractions
- Assume a positive mindset

What follows are example breathing exercises considered to be useful in the scope of Fit4Work and mental stress reduction.

2.1.1 Exercise 1

Instructions:

- Close your eyes and put your hand under your navel.
- Breathe in and conduct the air to the lower part of your abdomen.
- Breathe out and imagine you are blowing up a balloon.

Duration: approximately 3 minutes

Number of repetitions: 4

Figure 2.1 Breathing exercise 1

2.1.2 Exercise 2

Instructions:

- Close your eyes and put one hand under your navel and the other one on your stomach
- Breathe in two steps:
    - First conduct the air to the lower part of your abdomen
    - Second, conduct the air to your stomach
- Each time breathe out imagining you are blowing up a balloon.

Duration: approximately 3 minutes

Number of repetitions: 4

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Figure 2.2. Breathing exercise 2.

2.1.3 Exercise 3

Instructions:

- Close your eyes and put one hand under your navel and the other one on your stomach
- Breathe in and out in three steps:
  - First conduct the air to the lower part of your abdomen
  - Then, conduct the air to your stomach
  - And finally conduct the air to your chest
- Each time breathe out imagining you are blowing up a balloon.

Duration: approximately 3 minutes

Number of repetitions: 4

Figure 2.3. Breathing exercise 3.

2.1.4 Exercise 4

Instructions:

- Close your eyes
- Breathe in and out 3 times in the following way:
  - Breathe in and conduct the air to your navel and breathe out
  - Breathe in and conduct the air to your stomach and breathe out
  - Breathe in and conduct the air to your chest and breathe out
- Each time when breathing out, make sure it is long and you make a loud sound

Duration: approximately 3 minutes

Number of repetitions: 4

2.1.5 Exercise 5

Instructions:

- Same as exercise 4, except breathing out is quiet

Duration: approximately 3 minutes

Number of repetitions: 4

Figure 2.4. Breathing exercise 4.

2.2 Muscle relaxation exercises

Progressive muscle relaxation is a physiological method oriented towards rest, and especially useful in disruptions where an intense muscular rest is needed. Progressive relaxation training entails deep relaxation with little effort, allowing for voluntary control of the tension ease. It is a method that encourages the recognition of the intimate relationship between muscular tension and tense mental state, showing clearly how freeing one of them implies freeing the other. The whole body notices an improvement and that feeling is intensified with practice.

Progressive means that several relaxation and control states are gained gradually, but in a continuous way, little by little, but more intense and more effective every time. Jacobson teaches us how to relax the voluntary muscles as a way to reach a profound inner calm state, which happens when unnecessary tension leaves us. Freeing ourselves from the physical tension is an essential step to experiencing the sensation of calmness.

Muscular tension is stored in several body zones, and thus learning to relax various muscle groups that form our muscle tension map is a journey around our whole body.

This technique allows to lower generalized anxiety states, relax muscle tension, and improve sleep.

Below, example progressive muscle relaxation exercises are presented. Each exercise should consist of three phases:

- The exercise itself
- Mental review phase (with thoughts focused on sensations felt in exercised body parts)
- Focusing on pleasant thoughts

Each exercise also begins with sitting down comfortably and closing eyes.

2.2.1 Face, neck and shoulders.

Instructions:

- Wrinkle your forehead for a few seconds and then relax it slowly

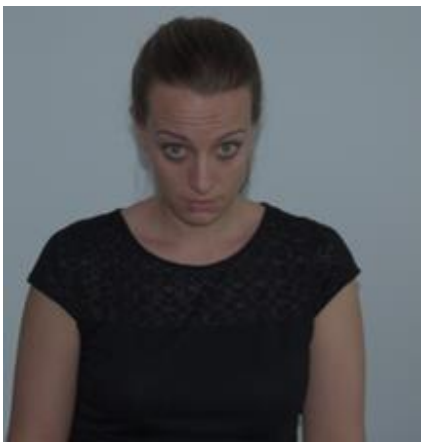

Figure 2.5. Wrinkling forehead.

- Open your eyes wide and close them slowly

Figure 2.6. Opening eyes wide.

- Wrinkle your nose for a few seconds and then slowly relax

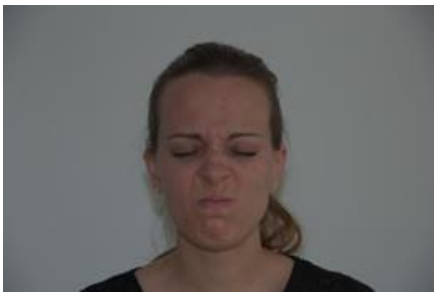

Figure 2.7. Wrinkling nose.

- Smile wide and then relax your mouth slowly

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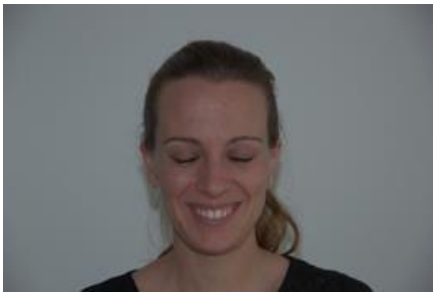

Figure 2.8. Smiling wide.

- Press your tongue against the roof your mouth and then relax slowly
- Clench your jaw and then relax slowly

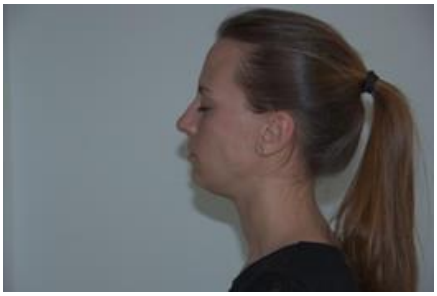

Figure 2.9. Clenching jaw.

- Flex your neck forwards and then slowly get it back into natural position
- Flex your neck backwards and then slowly get it back into natural position

Figure 2.10.Neck tenstion relief.

- Raise your shoulders and slowly lower them to the previous position

Figure 2.11. Raising shoulders.

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2.2.2 Hands and arms

Instructions:

- Close your fist and tighten arm muscles without moving it
- Feel the tension in your arm, forearm and hand and then relax slowly
- Repeat with the other arm

Figure 2.12. Arm tension relief.

2.2.3 Legs

Instructions:

- Stretch your leg, tighten it by pointing the toes upwards
- Feel the tense muscles and then relax slowly
- Repeat with the other leg

Figure 2.13. Leg tension relief.

2.2.4 Chest, abdomen and lumbar region

Instructions:

- Cross your arms over your chest. Lay your palms flat on your chest and pull back your elbows
- Feel the tension in the lower back and shoulders

- Breathe in and keep the air in your lungs for a few seconds. Notice the tension in your chest and breathe out slowly
- Tighten your stomach muscles and relax them slowly
- Tighten your buttocks and thigh muscles and then relax slowly

Figure 2.14. Relieving tension in the chest.

3 Initial prototype

The early mental stress relief exercise prototype has been implemented as a standalone Android (Google, 2017) mobile application. It contained 8 exercises - 5 breathing exercises and 3 muscle relaxation exercises.

3.1 General functionality

This paragraph presents general initial prototype functionality, focusing on the user facing features.

The functionality of this prototype was as follows:

- Performing 8 different exercises with
  - 5 breathing exercises
  - 3 muscle relaxation exercises
- Viewing general instructions on how to perform exercises
- Executing individual exercises in a group (breathing or muscle), or the whole group of exercises
- Filling out a pre- and post-exercise mental state form
- For breathing exercises
  - Each exercise described in one screen, with a single instructional image and text
- For muscle relaxation exercises
  - Each exercise step described in a separate screen with an instructional image and text

Limitations:

- Developed for in-project testing and exercise progress verification as a high-fidelity mock-up – actual stress levels not measured
- No voice instructions
- No automatic exercise progression

3.2 Exercise list

The following list of exercises was implemented:

- Breathing exercises (placeholder names for exercises were used):
  - “First exercise” – focused on lower abdomen
  - “Second exercise” – focused on stomach and lower abdomen
  - “Third exercise” – focused on chest, stomach and lower abdomen
  - “Fourth exercise” – focused on chest, stomach and lower abdomen with loud breathing
  - “Fifth exercise” – focused on chest, stomach and lower abdomen with quiet breathing
- Muscle relaxation exercises:
  - Head – focused on face and neck
  - Limbs – focused on shoulders, arms and legs
  - Torso – focused on the back, chest, stomach and waist

3.3 Implementation details

This paragraph presents exercise implementation details following individual screens of the initial exercise application prototype.

3.3.1 Main screen

The main screen allows the user to select between breathing and muscle relaxation exercises (see Figure 3.1).

Figure 3.1 Initial prototype - main screen

3.3.2 Mental state form

The mental state form (Spielberger, C. D., 1987) is designed to establish user's emotional state before and after each exercise session. The user answers 6 questions, some of them similar on purpose, using a 4-point scale (see Figure 3.2).

3.3.3 Breathing exercises introduction

The introduction screen is designed to deliver general recommendations for how the breathing exercises should be performed to minimize distractions and increase comfort and their effectiveness (see Figure 3.3).

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Figure 3.2 Initial prototype – mental stress form

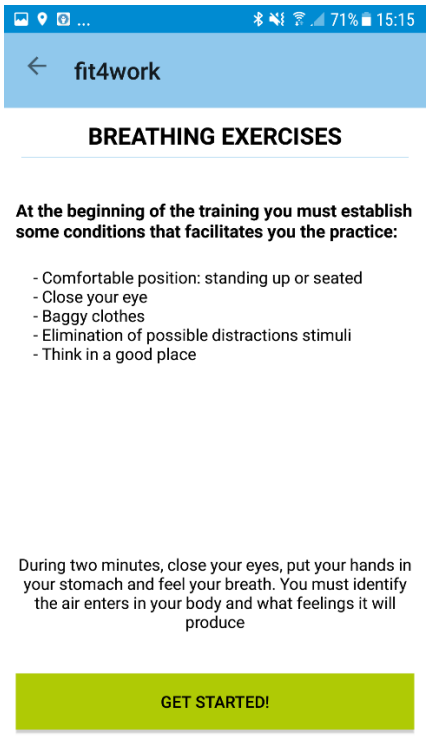

Figure 3.3 Initial prototype - breathing exercise intro screen

3.3.4 Breathing exercises main menu

Before starting to exercise, the user has an option to either perform a selected breathing exercise or all available breathing exercises (see Figure 3.4). If “Execute specific exercise” is selected, the user is taken to the screen shown in Figure 3.5. If the second option is selected, all exercises shown in Figure 3.5 are executed in sequence.

3.3.5 Breathing exercises list

This screen (see Figure 3.5) allows the user to select a desired exercise from the list (or finish the exercise session).

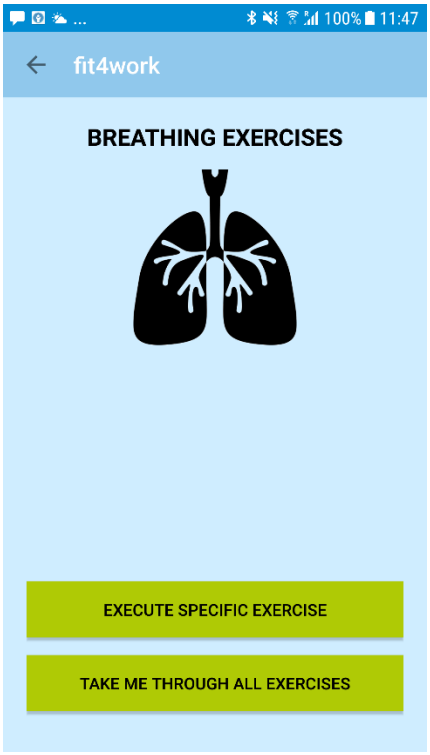

Figure 3.4 Initial prototype - breathing exercises main manu screen.

3.3.6 Breathing exercise execution

Once a specific exercise is selected, the application shows a screen with the exercise name, description and a single instructional image. The user can start the exercise and the application shows progress through 4 repetitions of the exercise (see Figure 3.6).

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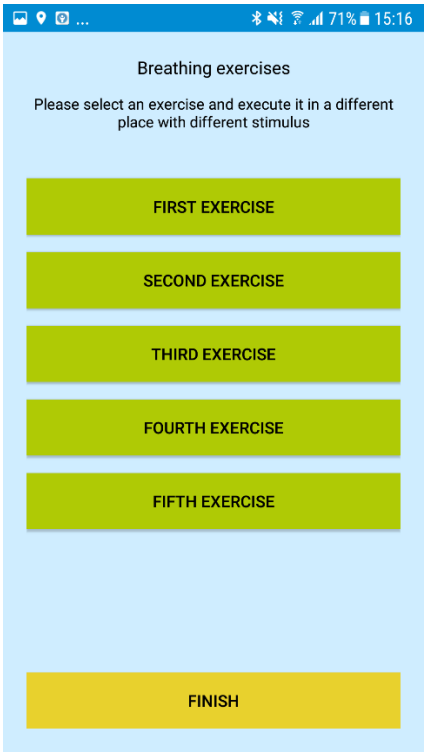

Figure 3.5 Mobile Applications initial prototype - select exercise screen

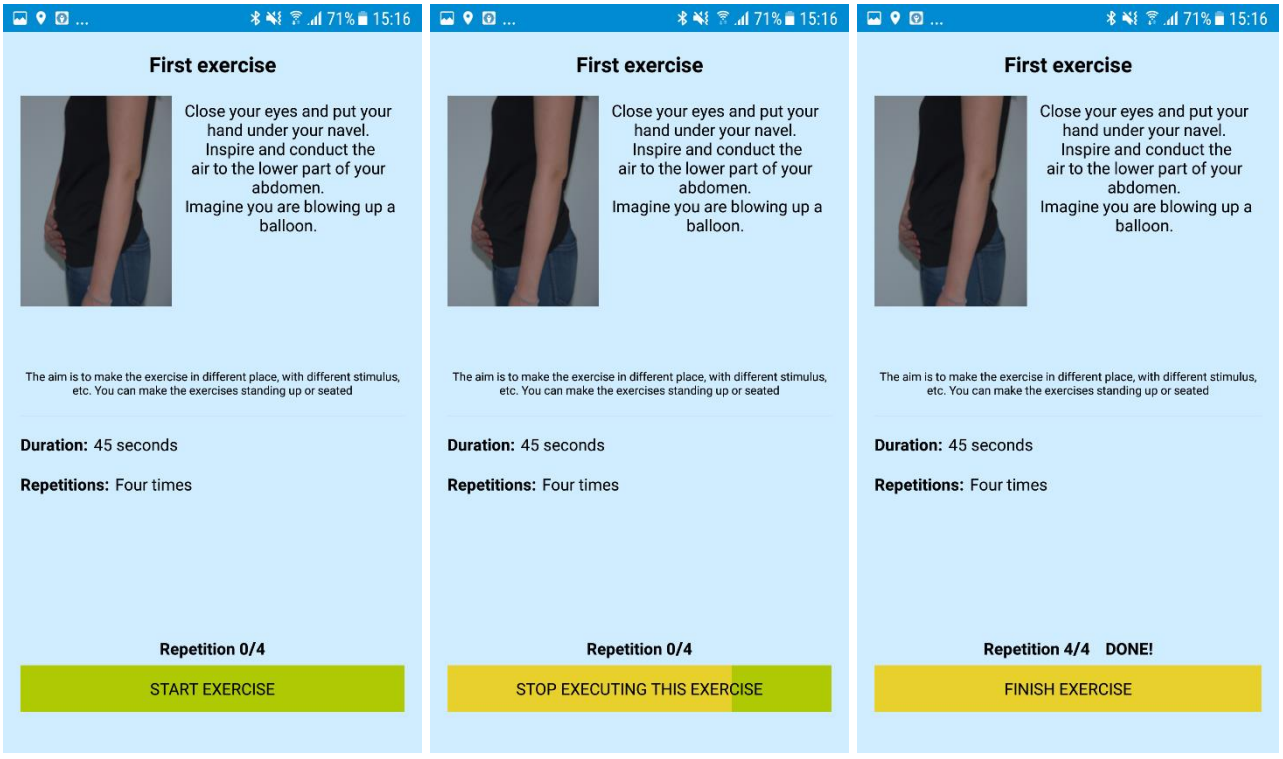

Figure 3.6 Initial prototype – start exercise screen, perform exercise screen, finish exercise screen

3.3.7 Muscle relaxation exercises introduction

Similarly, to the breathing exercise section, once muscle relaxation exercises are selected, the application shows an introduction screen describing three phases involved in this type of exercise (see Figure 3.7).

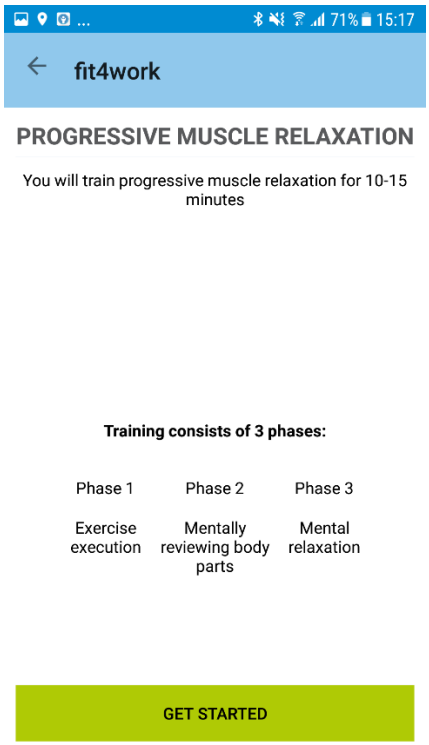

Figure 3.7 Initial prototype – muscle relaxation intro screen

3.3.8 Muscle relaxation exercises list

The muscle relaxation exercises list screen provides the user option to either execute one of the 3 exercises, or all of them in sequence (see Figure 3.8).

3.3.9 Muscle relaxation exercise execution

Muscle relaxation exercise execution differs from breathing exercise execution in that the user manually goes through a series of screens, swiping right to left. An intro screen is presented, showcasing the muscle group the following exercise steps will concentrate on, and then screens with exercise steps, each with a name, description and instructional image (see Figure 3.9. and 3.10).

3.3.10 Muscle relaxation exercise mental review

After each of the muscle exercise executions, a mental review phase is started. The user is asked to mentally scan a particular region of their body they just worked on during their exercise (see Figure 3.11).

When the review stage is finished, the user is asked to concentrate on thinking pleasant thoughts in the final phase (see Figure 3.12).

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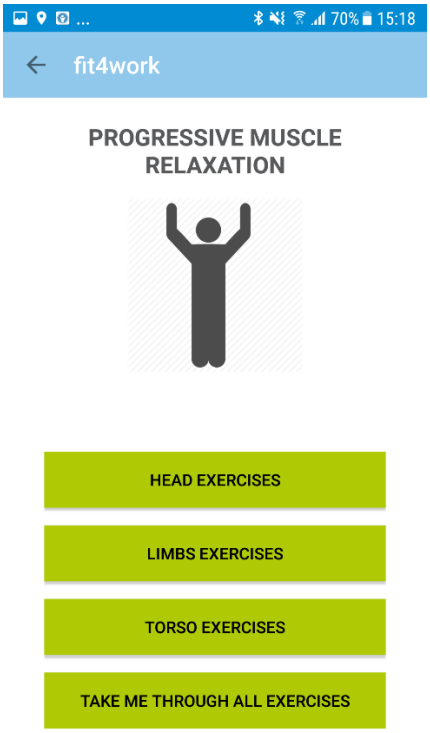

Figure 3.8 Initial prototype - select muscle relaxation exercise screen

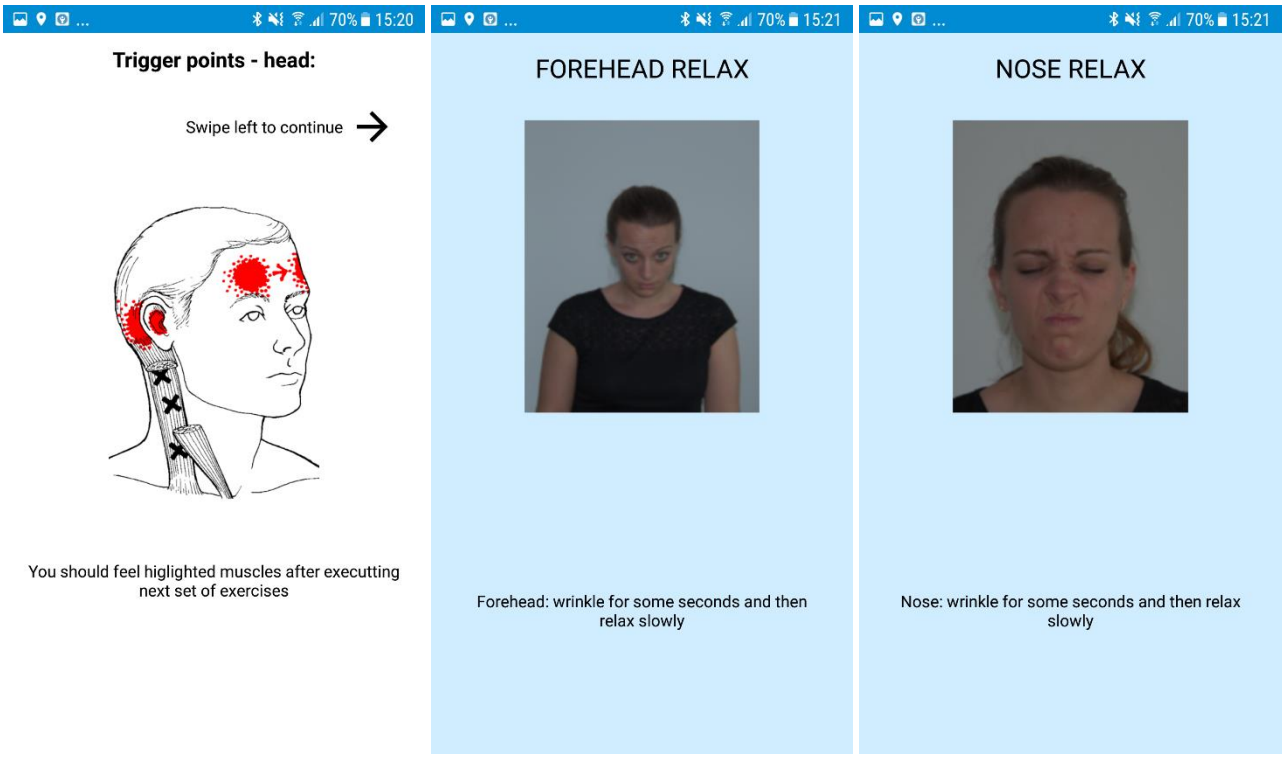

Figure 3.9 Initial prototype – start exercise screen, perform exercise screen step 1, perform exercise screen step 2

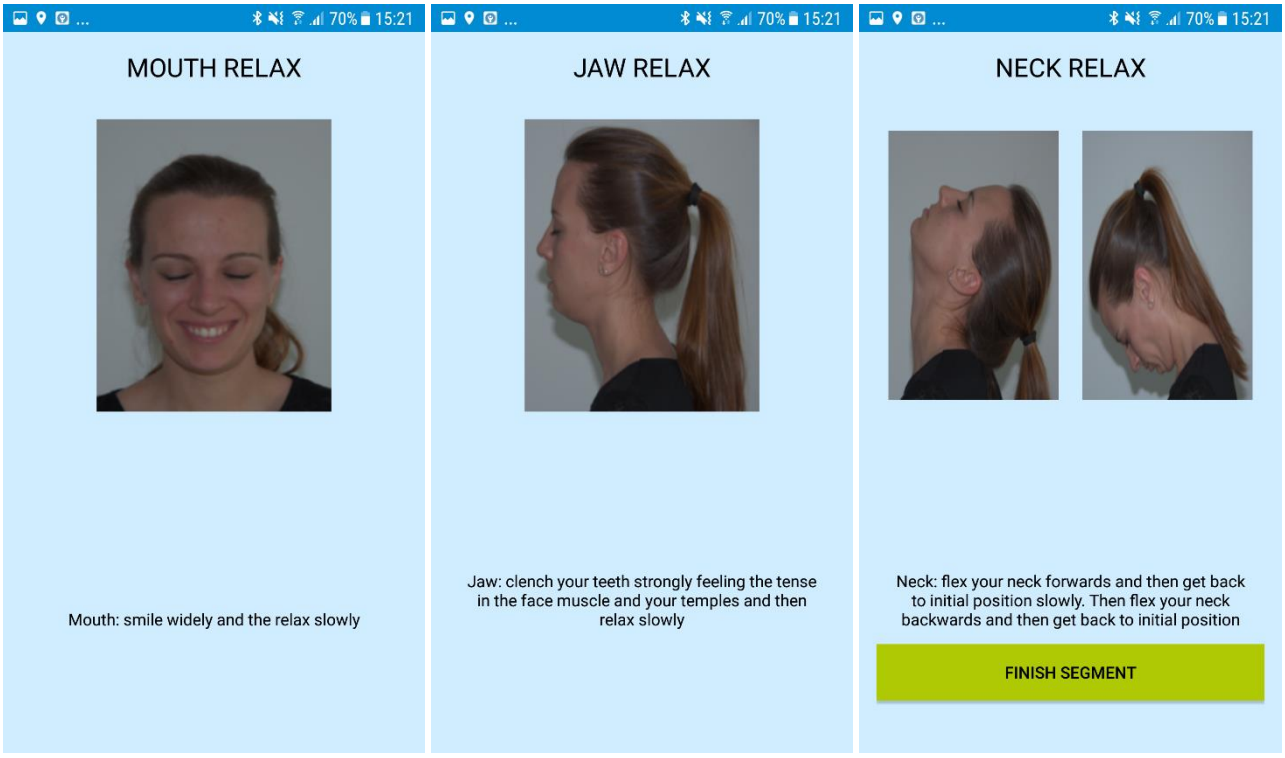

Figure 3.10 Initial prototype – perform exercise steps screens and finish exercise screen.

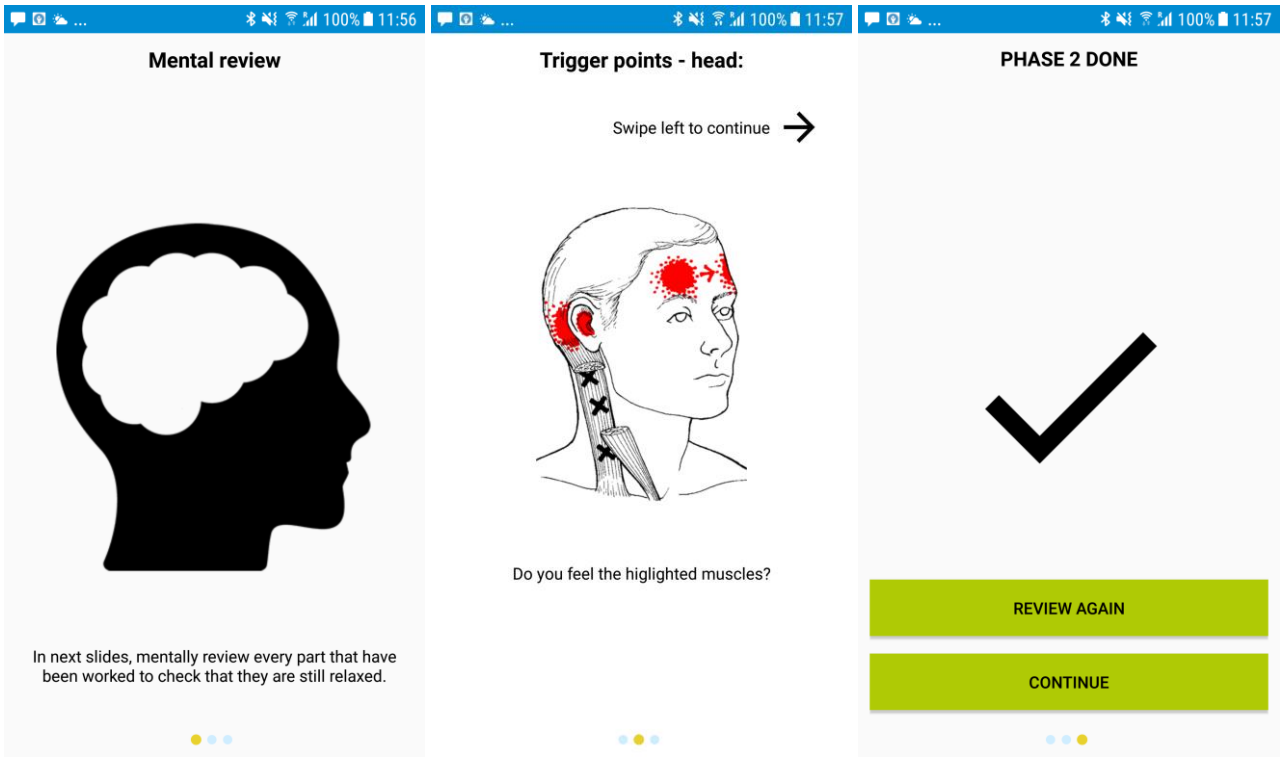

Figure 3.11 Initial prototype – introduction to mental review, perform review and finish review screen

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Figure 3.12 Initial prototype – "Thinking pleasant thoughts" screen.

4 Final prototype

The final prototype of stress relief exercises has been incorporated in the Mobile Application (for detailed description of this application, please refer to Deliverable 4.2.1/4.2.2 (Bogdański, M., et al, 2017b) and Deliverable 5.4.1/5.4.2 Prototypes of the Fit4Work system (Bogdański, M., et al, 2017a).

The Mobile Application has been implemented on the Android platform (Google, 2017) with the stress relief exercises becoming a module of this application (see Figure 4.1).

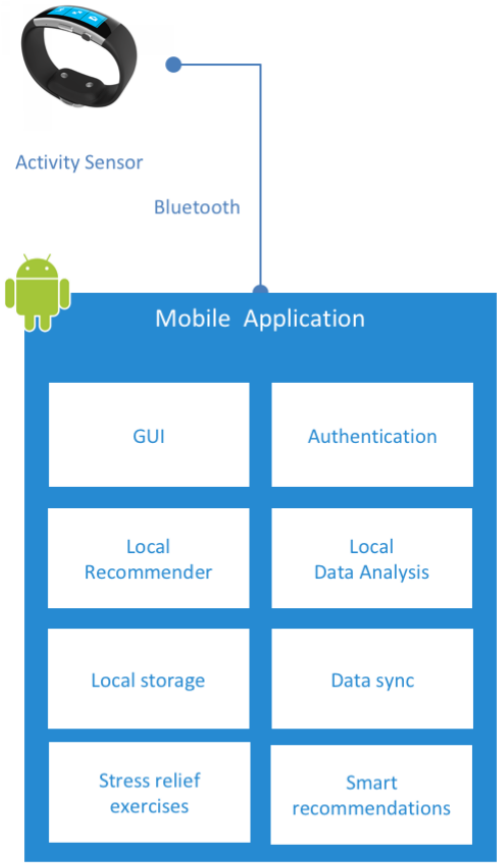

Figure 4.1 Stress relief exercises module within the Fit4Work Mobile Application

4.1 General functionality

Changes have been made to the functionality of the final prototype as compared to the initial prototype. They focused on simplifying the exercise execution session and exercises themselves.

This paragraph, again, presents general final prototype functionality focusing on the user facing features.

The functionality of this prototype as compared to the initial prototype is as follows:

- Performing 8 different exercises with:

  - 4 breathing exercises (one exercise omitted because it was essentially duplicating another one)
  - 4 muscle relaxation exercises
- Exercise execution session process is now uniform across all types of exercises – i.e. selecting exercise from combined exercise list, progressing through steps in exercise and viewing a summary
- Automatic session progress with a session summary
- Each exercise has a meaningful name, description and a defined number of discreet steps
- Each exercise step is associated with:
  - Step description (spoken out loud by the application)
  - Calming image (chosen randomly from pre-selected set of images) - instructional images have been replaced with calming images. It has been established that instructions for exercises are easy enough to understand without illustrating them with images. Additionally, it is recommended to have eyes closed during all exericises.
  - Execution time in seconds
- Presenting a stress relief exercise recommendation when high levels of stress have been detected
- Monitoring user heart rate and relaxation level with the help of Microsoft Band2 (Activity Monitor) (Microsoft 2017)
- Mental state form step has been omitted in order to decrease time needed to perform exercise (it has been viewed as pure research tool to begin with).

4.2 Exercise list

The following list of exercises has been implemented:

- Breathing exercises:
  - Lower abdomen – breathing exercise focused on your lower abdomen.
  - Lower abdomen and stomach – breathing exercise with attention focused on your lower abdomen and stomach
  - Lower abdomen, stomach and chest – breathing exercise with attention focused on your lower abdomen, stomach and chest.
  - Lower abdomen, stomach and chest with sonorous breathing – breathing exercise with attention focused on your lower abdomen, stomach and chest witch loud breathing.
- Muscle relaxation exercises:
  - Face, neck and shoulders – muscle tension relief exercise focused on your face, neck and shoulders.
  - Hands and arms – muscle tension relief exercise focused on your hands and arms.
  - Chest, abdomen and waist – muscle tension relief exercise focused on your chest, abdomen and waist.
  - Legs – Muscle tension exercise focused on your legs.

4.3 Implementation details

4.3.1 Exercise prompt

When high levels of stress are detected, Fit4Work generates an instant recommendation prompting the user to perform a stress relief exercise (see Figure 4.2).

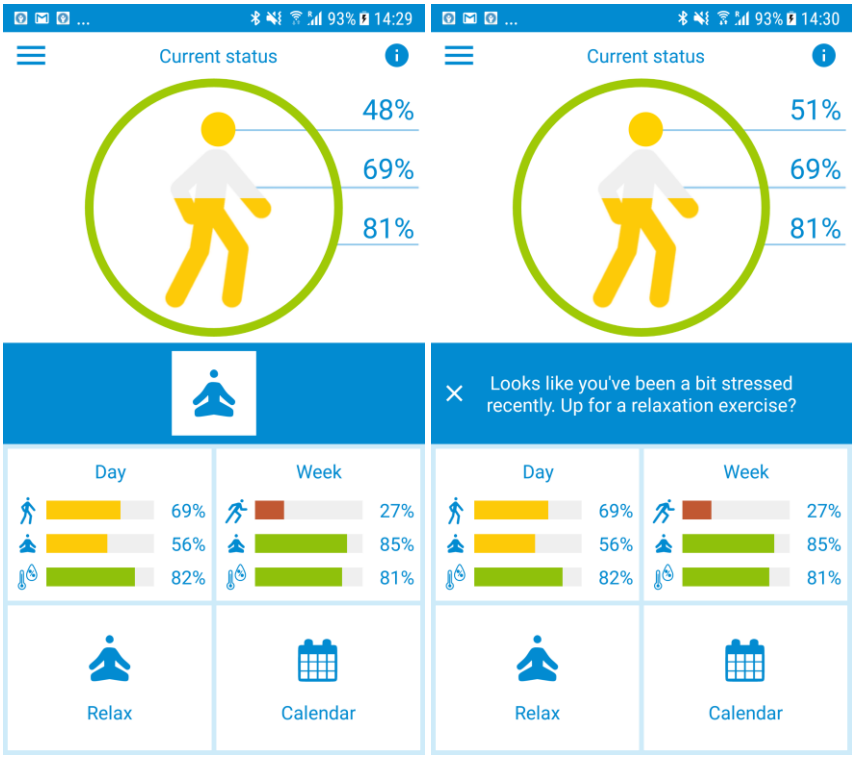

Figure 4.2 Mobile Application final prototype main screen – relaxation exercise recommendation, expanded instant recommendation text

4.3.2 Exercise introduction

When the user selects the "Relax" option on the main screen, they are taken to an introductory screen. If the user hasn't performed any stress relief exercises yet, the application introduces them shortly. After an exercise has been performed, this screen shows a summary of total time the user has spent performing stress relief exercises and the date when the last stress relief session was conducted (see Figure 4.3).

4.3.3 Exercise list

The user is presented with a scrollable list of all stress relief exercises, divided into breathing and muscle relaxation (see Figure 4.4). One exercise is selected by the system as recommended (based on previous results and level of stress).

Each exercise has a meaningful name, short description and total time it will take to execute it (calculated automatically by adding up duration of each step).

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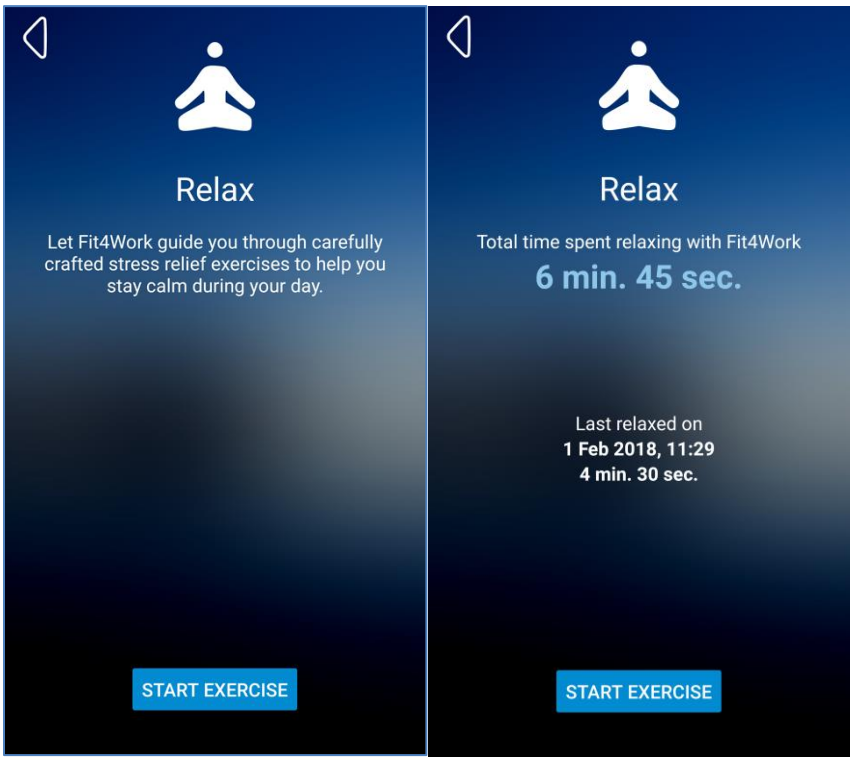

Figure 4.3 Final prototype – intro screen (no stress relief exercise performed yet, stress relief exercises performed before).

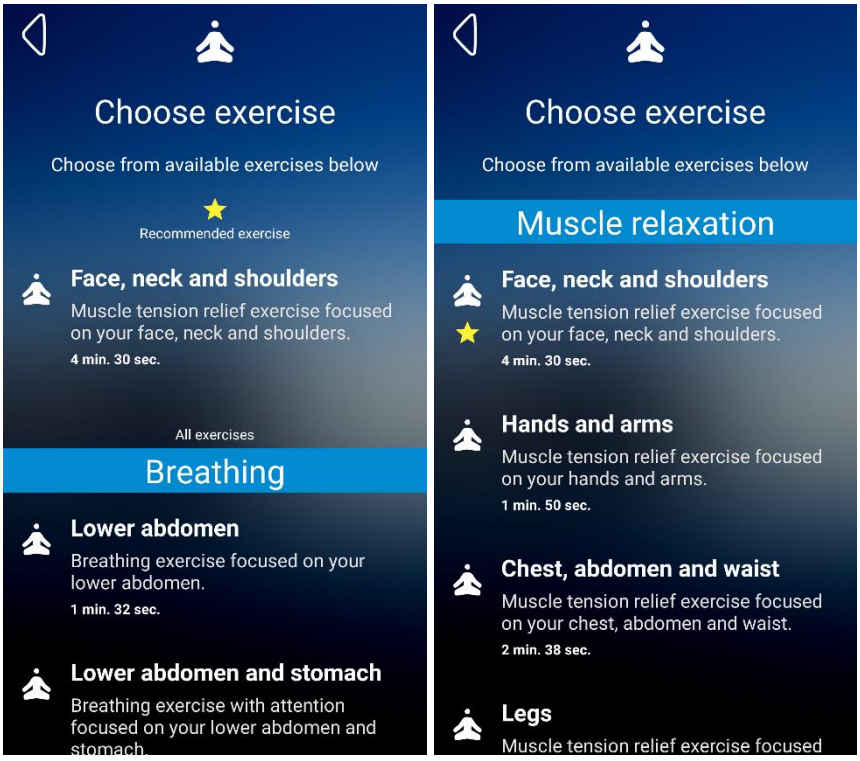

Figure 4.4 Final prototype – exercise list screens.

4.3.4 Exercise execution

Once an exercise is selected by the user, an exercise execution session begins. The application automatically progresses through all steps defined for the exercise, giving the user spoken instructions using Android's text-speech synthesis. The speech synthesis speed has been slowed down from the default speed, in an attempt to increase the calming effect.

The user is prompted to close their eyes and sit down comfortably in the first step of each exercise, and this is one of the reasons why spoken instructions are used. Should they wish so, the user can pause and resume the exercise at any moment and see their progress through it (progress bar at the top). They can also stop the exercise altogether before it naturally completes (see Figures 4.5, 4.6).

Muscle relaxation exercises include a mental review and thinking pleasant thoughts phase (see Figure 4.7).

The user is informed about the end of each exercise (see Figure 4.8).

4.3.5 Exercise execution summary

When the exercise session naturally completes, the application automatically takes the user to a summary screen presenting a congratulatory message, user's heart rate and relaxation score at the end of the session (see Figure 4.9).

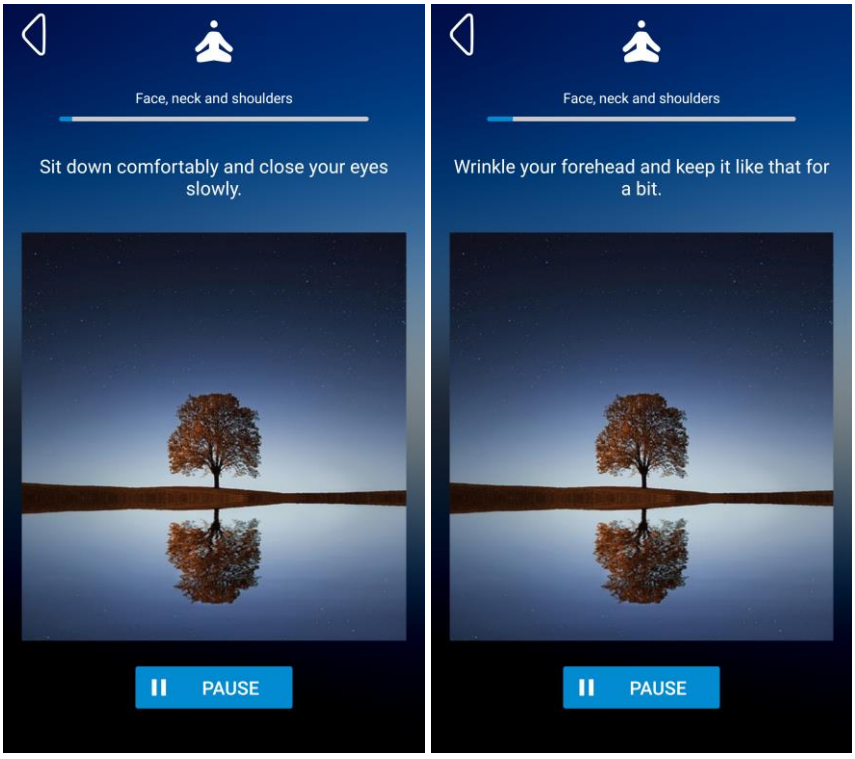

Figure 4.5 Final prototype – progressing through an exercise

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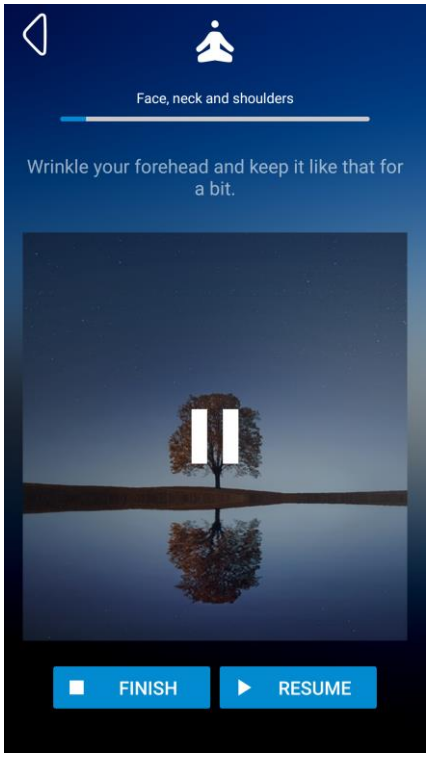

Figure 4.6 Final prototype – performing exercise screen (exercise paused).

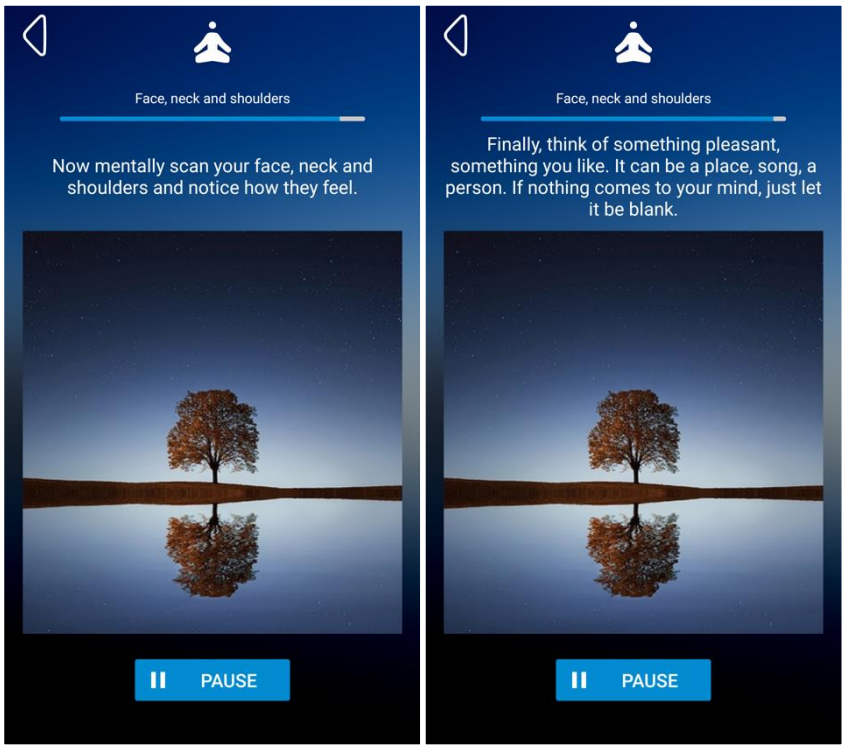

Figure 4.7 Mental review and pleasant thoughts phases.

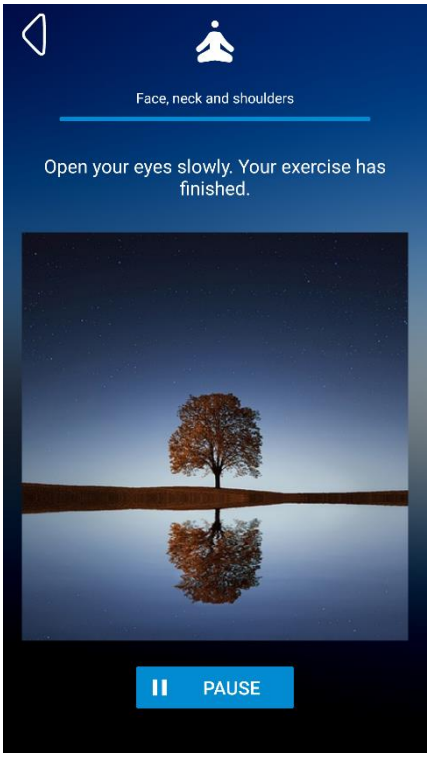

Figure 4.8 Final prototype – performing exercise screen (finishing exercise).

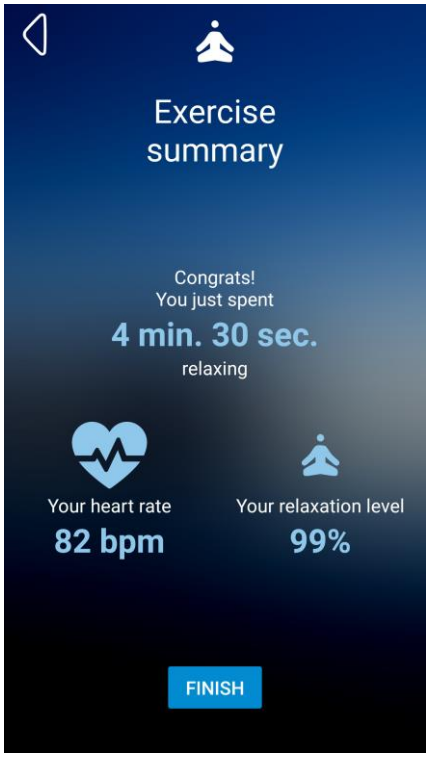

Figure 4.9 Final prototype – exercise summary screen.

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5 Summary

Monitoring and managing user's mental stress is an important part of Fit4Work. Complex, machine-learning algorithms for detecting high mental stress events are backed by supporting the user in alleviating tension by providing the ability to perform guided stress relief exercises. The theoretical basis for such exercises has been presented in this report.

In the course of the project two prototypes of such exercises have been developed and they have been described in detail above. The initial prototype was a standalone mobile application intended for verification of the exercise content and process between the development team and specialists providing domain knowledge, with participation of representatives of end users. The final prototype has been implemented as a module of the Mobile Application. The exercise process, exercise content and graphic design have been optimized for usability and effectiveness in mental stress relief.

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