TU/e EINDHOVEN UNIVERSITY OF TECHNOLOGY

Project 2
Social Inclusion & Physical Rehabilitation
Bascule II

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The Project

The Bascule is an organization for psychiatric help to children, adolescents and their parents in and around Amsterdam. For three years there is a special department at the Bascule with the name ‘020’.

Adolescents who are following treatment for their illness can contact this department 24/7 for online and offline coaching to lower their stress level. They will be coached and can practice their coping skills.

At ‘020’ there are different rooms where the adolescents can pull back. We would like to design the chill-out room with the use of the latest technology and optimize this room as a place to distress.

Concepting Phase

The first step towards a good project is to define a project goal. This goal can be described as “creating a room that helps patients to calm down in a natural way by taking their own preferences into account with the help of technology”.

Brainstorm

With the goal of the project and some general research about Bascule 020 in mind we brainstormed. In this brainstorm, we thought about different kinds of rooms that can be designed. For example: should the room be interactive or static? After this brainstorm, our plan was to create a room with a calm arrangement, but also containing interactive attributes which help the user to calm down actively. These should be adjustable to one’s personal preferences or needs.

The next step is to gain knowledge about the topic that is addressed. In this case, the conducted research was aimed at techniques to calm people down and the sort of psychiatric backgrounds of the adolescents our client is dealing with.

Research

The sort of psychiatric problems that the adolescents face is very broad, this goes from anorexia to suicide attempts. Everyone who is being treated by Bascule can make use of the chill-out room. Since Bascule treats a lot of different problems it is hard to draw a clear conclusion. However, there are other institutes that also use a chill-out room for people with psychiatric problems and the need to de-stress. An example is: “As an alternative to the traditionally uncomfortable time-out room, a comfort room was constructed on an acute adult inpatient unit. This space was designed with comfortable furniture, soothing colors, soft lighting, quiet music, and other sensory aids to help reduce unsettled patients’ level of stress.” [8] Other rooms that help both children as well as mentally impaired and elderly calm down are called `Snoezel` rooms. These are multi-sensory rooms for sensory modulation. Snoezelen entails nice sensory incentives, for example, touching soft materials and using special light effects and scents. [25]

The results of the research towards techniques to calm people down are that in general color, light, scent, sound and touch are important. Short said; everything that can influence the human senses.

It was clear that the most important outcomes were that pictures of places with good memories calm people down, colors lift the spirit, plants can help with relaxation and projections of light can relax people. [20] [21] [24]

For smell; a perfume that reminds of nice people and aromatherapy are used to relax people. Taste can also influence your stress levels. People on relaxing people, this can be relaxed by eating their favorite food, eating candy or chewing gum. [20] [24]

Movement can be an important aspect in calming down as well. This can be done by small movements for example when using a stress ball, breathing and crafting: “Repetitive motions -- like the fine motor skills used to knit, make jewelry or cross-stitch -- can soothe anxiety, according to avid knitter and paediatrician, Perri Klass, M.D. Mindfulness expert Dr. Herbert Benson agrees: Knitting fulfills the two criteria of mindfulness practice, as he sees it: “the repetition of a sound, word, phrase prayer, or movement, and the passive setting aside of intruding thoughts and returning to the repetition.”[20] but also by bigger movements as exercising and a technique

called progressive muscle relaxation. The last works in the following way: “Start with your toes and work your way up: tighten your foot muscles as much as you can, then relax them. Make your way up, tightening and relaxing each muscle until you’ve finished with your face. It may seem silly, but this practice can help reduce anxiety and stress and is often recommended to patients who suffer from depression and anxiety disorders.” [20] [24]

The last subject is sound, hearing one’s favorite songs gives the following result: “While classical music has a particularly soothing effect -- it slows heart rate, lowers blood pressure and even decreases levels of stress hormones -- any music that you love will flood your brain with feel-good neurochemicals like dopamine.” [20]. More in general, uplifting music, sounds of nature and fountains can help relax people. [24]

These aspects can differ for every person, but most of them have a solution that fits everyone. To define what these solutions are further research is done. In this research, only the aspects that are implemented in the end-product are investigated. The reason that sound is not part of this is due to the personal preferences that people have. According to Pelletier, C. L. sound does help with relaxation but the amount of it differs for each person. According to Leardi, S. Et al. sound helps especially when selected by the user itself. [22] [16] This also applies for taste and movement. The reason that smell is not implemented in the room is that smell also is very personal and changing smell will create an overkill of different smells since the room will be used by different people during the day.

Light

Light can have a huge impact on somebody’s mood. Too much or too less can cause a negative mood while just enough light provides a positive mood. According to the experiment of Ballal, S. Kuller, R. Laike, T. Mikellides, B. Tonello, G. (2007) mood shifts occur more during the year to people who live far from the equator than to people who live close to it. Besides that the intensity of light is important too, too dark or too light can affect one’s mood. [4] Another experiment that shows how important light is, is that of Altimus, C.M. Hattar, S. Kirkwood, A. Lee, H. LeGates, T.A. Wang, H. Weber, E.T. Yang, S. Zhao, H. (2012). In this experiment, they showed that “light directly regulates mood-related behaviors and cognitive functions in mice.”[1]. These experiments show how important light is and how it can influence one’s mood, therefore, we decided that light should play an important role in the chill out room.

For these reasons, we chose to implement a function in the room that makes it possible to adjust the brightness of the light in the chill-out room.

Colour

Besides the amount of light, the color of light is also important. According to multiple experiments, the color combination blue and green is the most calming. [2][7] [11]. Church T. (2002) states that “For bedrooms, purples, greens and blues may be used to produce a calming atmosphere. Blues and greens are still highly preferred by the adult population and this may be one reason why, because it provides calm. Since green is the easiest color on the human eye, it may be beneficial to use greens in general living areas.” [7] A paper that supports this is the one of Epps, H.H and Hall, D (2004), in their experiment most positive emotions occurred to the combination blue and green. [11]

However, according to Church T. (2002), the color preference in the work environment is different for everyone. The research of Epps, H.H and Hall, D (2004) also mentions that most positive emotions occur to yellow when a single color must be chosen. In this research it also becomes clear that blue can have very different meanings, it can be calming but also depressive. This is due to different meaning people give to colors: “In the present study, the findings revealed that the color white was seen to be generally positive and was associated with purity and being simple and clean. Some respondents associated white with innocence and peace and said it reminded them of a bride or dove. Another said the color white reminded her of snow. However, it also evoked negative emotions and was associated with empty-ness and void.”

Taking this into account, the room must have a general calm color, but the light of the room must be adaptable to people’s own preference. With the general colors most people would feel calm, but with the adjustable light, the group that has another preference for a calm color can select their own calming light. Our research showed that the colors which have the most calm and positive effect are white, blue, green, yellow and purple. Therefore, we chose to implement a function in the room that enables the user to choose which of these five colors he wants the light in the room to be. [2][7][11]

Patterns

In the study of the California Long Beach state university about a biofeedback program for stress among college students, the program emWave is discussed as a good option. This product consists of a device that shows direct biofeedback to its user via LEDs. Besides this, it can also be attached to a computer and show a pattern that is adjusted to the heartbeat of its user. [13][12] “Through the biofeedback of the emWave unit, students learn to produce hearth rhythms that are associated with positive emotions which reduce their stress level and improve their overall well-being.” (Hayashino et Al)

To implement a pattern that gives the user biofeedback we decided to use a standard breathing frequency. According to “The normal number of respirations for a non-respiratory compromised healthy adult is between 12 and 20 breaths per minute” [3] Therefore we chose to implement a function in the room that makes the light pulse on a calm frequency of 12 breathings per minute (this is 0,2Hz).

Visuals

According to Browning, W.D., Ryan, C.O., and Clancy, J.O views of nature reduce stress, even when those views are images instead of a real view. The preferred view is looking down a slope to copses of shade trees, flowering plants, calm non-threatening animals, indications of human habitation, and clean water. The reason that views of nature are preferred over views of non-nature scenes is that scenes of nature stimulate a larger portion of the visual cortex, which triggers more pleasure receptors in the brain, that leads to longer interest and faster stress recovery. [6] According to the study of de Jonge, J.E. “visual natural stimuli, both photographs and videos, can foster recovery from a stressful situation.” [9]

Moving visuals can distract people from what is on their mind, these visuals could be moving clouds, plants, water and organisms. The importance of visuals is also shown in the report of Browning, W.D., Ryan, C.O., and Clancy, J.O, a more positive reaction is given when visuals are added to sound. [6]

As mentioned in the first research, visuals of people or places with good memories calm people down. A device that uses this is the Qwiek.up, this device is used for elderly and mentally impaired people. The device creates an audio-visual experience. The Quick.up distracts people during stress moments by using the Snoezelen technique as mentioned before. [23]

With this knowledge in mind, we chose to implement a beamer in the chill out room. The beamer will display a set of pictures which will be projected on one of the walls.

Which picture is displayed can be controlled by the user. He/she will be able to choose between pictures of forests, water, cute animals, landscapes and other calming views. We have chosen not to implement personal pictures because these can also recall bad memories. For example, when a person on that picture is just passed away. A solution for this could be to let the user chose the pictures every time they use the room, but during the second visit at bascule, which will be mentioned later, the users made clear that they do not want to do many proceedings when they enter the room. Another reason not to implement this is privacy, this because multiple people are using the room.

Interview

After we had enough knowledge about the topic, we conducted an interview with a psychiatrist. From this interview, the following is concluded:

- In general, all members have multiple problems. Stress is in almost all cases an effect of this and facing a lot of stimuli is bad for them.
- The organization of this psychiatrist is alsoare developing visuals (a game) to calm children. Therefore, she thinks that there are enough opportunities to design something in this area.
- Own preferences are important. Having a personally customized room is good for the visitors.
- A risk with using visuals is that more stimuli can be created.
- A room that can be customized to own preferences can reduce stimuli
- The idea of making a pre-selection of what the room can offer (only providing researched proved calming colors, images, etc.) is good.
- Bio-feedback is a good idea. Some people come in with a too high or too low heart rate. Therefore, using bio-feedback to show them that their rate is too high and use it to bring it up or down is a really good idea in her opinion.

Afull summary of this interview can be found in the appendix p.20.

Bio-feedback

As mentioned before the emWave is used to give feedback via lights. Another bio-feedback device is the ‘BioFidget’ of Rong-Hao Liang et al. [17] These examples show that breathing slower will reduce stress. During the mid-term demo-day, the advice was given to talk to Rong-Hao Liang about the ‘BioFidget’. During this visit, it became clear that direct feedback works best. Rong-Hao Liang mentioned that the device should be designed in a way that nothing must be attached to the user, the user also mentioned that they do not want to do a lot of acts when entering the room. With this in mind, the fidget cube heart rate sensor was made. The user does not have to attach something to them, but they do get direct feedback.

In the experiment of Hellhammer et al (2004) the participants had to do a stressful task in the morning and afternoon. The results are the same in both moments. The heart rate when neutral is less than 85 and the heart rate when stressed is more than 85. Bardwell et al (2009) did an experiment where the participants had to do a speech task. It was then measured what the heart rate was during the stressful task and both before and after that task. The heart rate baseline was at maximum 83,66 and the heart rate during the experiment was at least 87.4. [14][5]

To implement this bio-feedback into the chill-out room we made a tangible object that would measure the heart rate

and give the feedback. The design of this object is based on a fidget cube, just as the manual of the room. This in order to make the process of measuring the heart rate non-clinical and easy. The user only has to place his finger on one of the surfaces of the cube. In this way, the client doesn’t have to put any equipment on, which would be very annoying when they are feeling stressed as it would be an extra action to go through before starting the process of getting calm. The cube also consists a led. The led has a green light when the heartbeat is beneath 85, and a blue light when the heart rate is between 85 and 95 bpm. The led is off when the heartbeat is above this. We chose to only provide positive feedback. The reason for this is that negative feedback does not help the patients as multiple sources show. [27][26] Based on the two experiments mentioned above the heart rate has a flip point at 85 beats/minute. [14][5]

The client

Besides research, the wishes of the client also must be considered. During the first visit at Bascule 020, the employees told what they would like to be in the chill out room. The idea that we proposed, a room that can be changed towards one’s preferences, was received positively. They wanted us to do something with the light and the colors of the light. Right now, there is a wallpaper of a forest to make the room appear less clinical, they wanted to keep such an idea but with brighter colors. This fits with the research that showed that green is a calm color.

The client also mentioned that they would like a hammock or beanbag in the room, so the user can sit in it in a comfortable way. Sound was also an important aspect since the room has a very loud air-conditioning system. However, this will not be included in the device because the client is going to solve this problem on their own.

The user

To find out what the user needs, a questionnaire is conducted. The users could anonymously tell what they would like to have in the chill-out room. Down here, the questions with a summary of the answers can be found:

Q1: On what moments do you visit the room?

A: Stress, tension, depressed, need to segregate.

Q2: What makes you calm? (Think about smells, favorite places, etc.) Please explain why.

A: Nature, sounds, smells, soft things (hard things can trigger me when there is a war going on in my head) (cushions are mentioned multiple times), a place without people but not deserted.

Q3: What places do you feel most comfortable? Please explain why

A: In someone's arms, in nature, places with soft colors, home environments, spacious things.

Q4: What do you usually do in the room?

A: Try to calm down, listen to music, punch a pillow, cry, read, nothing.

Q5: How long do you generally stay in the room?

A: 10 – 45 minutes. This varies for everyone depending on their mood.

Q6: Do you like to be alone in the room?

A: Yes, but some do not really care.

Q7: What are suggestions from your side about the room?

A: Satisfying things, music, soft things, smells, decoration, views (everyone has their own preferences).

Prototyping Phase

Choices

To choose what will be implemented in the room the interviews with the client, users and the research are taken into consideration.

Putting this all together the room will contain:

- A calm arrangement.
- A control panel (design based on a fidget cube) that controls the color of the light (blue, green, purple, white or yellow) and the brightness.
- A beamer that projects a set of different calming pictures on the wall, also controlled by the control panel.
- A fidget cube that gives only positive biofeedback with the help of a heart rate sensor and a led.

Arguments for the choices can be found below.

The 3D model

To get a better impression of how the room would look like, a 3D model of the room was made in SketchUp. We chose for a wall with a bright picture of a forest as a standard decoration for one of the walls. As mentioned in the research, pictures of nature work well for reducing stress. Because the room will be customizable, this picture is placed behind the couch and not directly in front of the visitor. The visitor

looks to the wall where a beamer will project pictures which the user selects. Other studies have shown that an almost symmetric room is calming. [19] Therefore, the sofa is placed in the middle, two speakers in the corners and a table with plants on each side of the room. To “break” the symmetry, but nevertheless keep the effect of it, a guitar will be placed on one side of the couch, and a bean bag on the other side. The guitar is occupational therapy. According to the research, nature is relaxing, for that reason plants are placed in the room, our user questionnaires also showed that the users liked plants in the room. During the first visit at bascule, the client told that people liked the beanbag because it was in a corner where the visitors were not directly seen and had a clear overview of who was in the room. Therefore, the beanbag is placed in a corner behind the sofa, to create this same effect in our room. The colors of the interior are simple so that no one will experience stimuli of complex colors.

The product

For the control of the whole room we chose the design of a fidget cube. Because its purpose is already to calm stressed people down, we thought the design would fit the purpose of the room.[18] Besides that, we wanted the control panel to be a playful device instead of a static boring control panel. In the first place because our user group consist of adolescents, and in the second place because a static panel would feel more clinical, the client mentioned to prefer not to have a clinical feeling. Four sides of the cube will be used for the system. One side of the cube is provided with 2 buttons to scroll through the pictures displayed on the walls. Two opposite sides will be used to put on or turn off the pulsing of the light and to change the light intensity. The top side will be used to change the colour of the light. To show how the eventual device will look we made a small-scale 3D

Figure 1

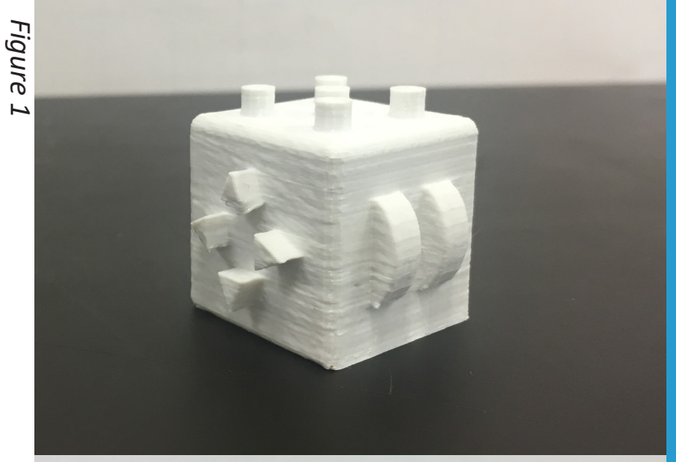


Figure 2

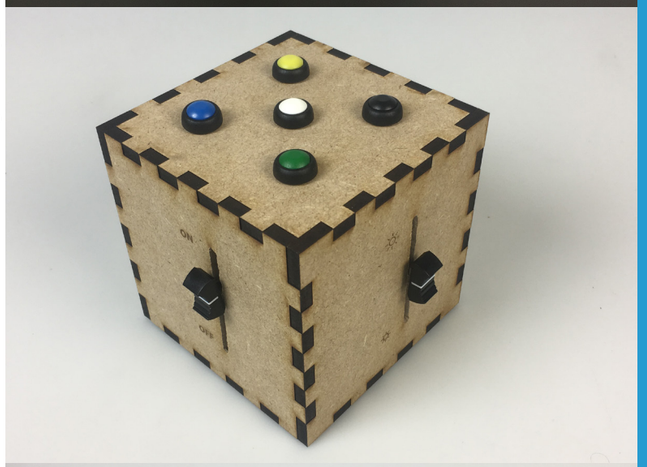


Figure 3

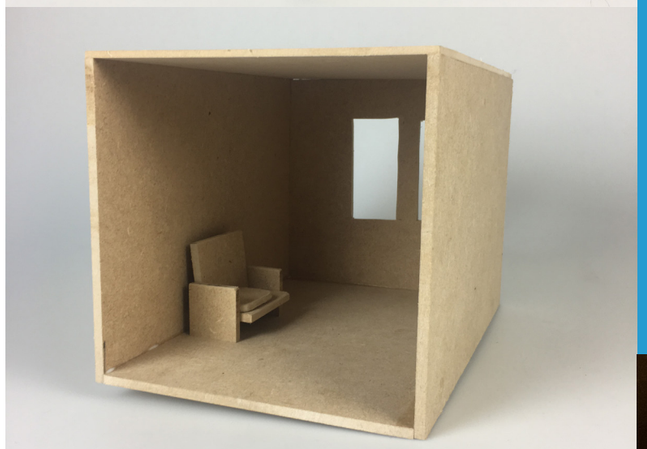


Figure 4

(fig 1). For the mid-term demo day, only light is implemented in the device (fig 2&3). To show what the visuals will look like a laptop with visuals is presented (fig 4).

Feedback Phase

During the presentation on the mid-term demo day, we received some useful feedback. The most important feedback was that the pulsing light would be too much and would maybe give a scary and overwhelming effect. One preference was to use a single object that the user can hold with pulsing lights in it. The reactions to the colors of the light were positive. Other feedback was aimed at the biofeedback part of the project, people were enthusiastic about it and referred to a paper of Rhong-Hao Liang et al. about the ‘BioFidget’, a fidget spinner with biofeedback. [17]

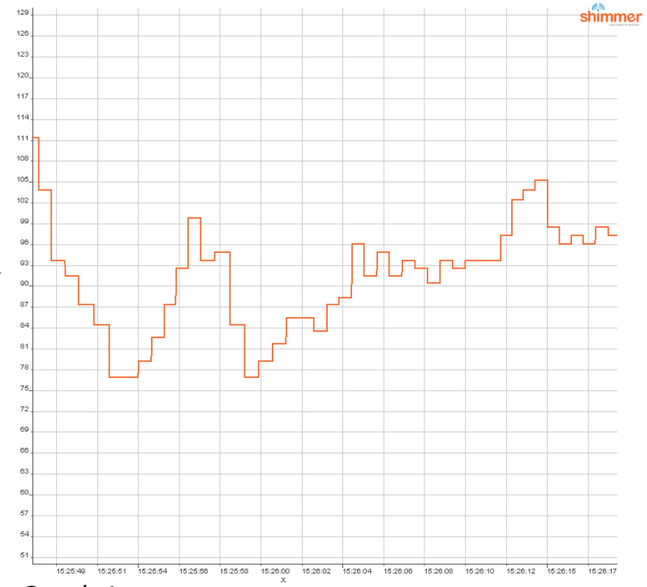
The most important change to our design after this phase is that we decided to put the pulsing light into an object instead of letting the whole room pulse. Reminding ourselves to the visit at Bascule and the questionnaires we conducted, we thought about how a lot of users of the chill-out liked to hold a pillow when sitting in the room. Therefore, we decided to put the pulsing lights into a pillow.

Testing Phase

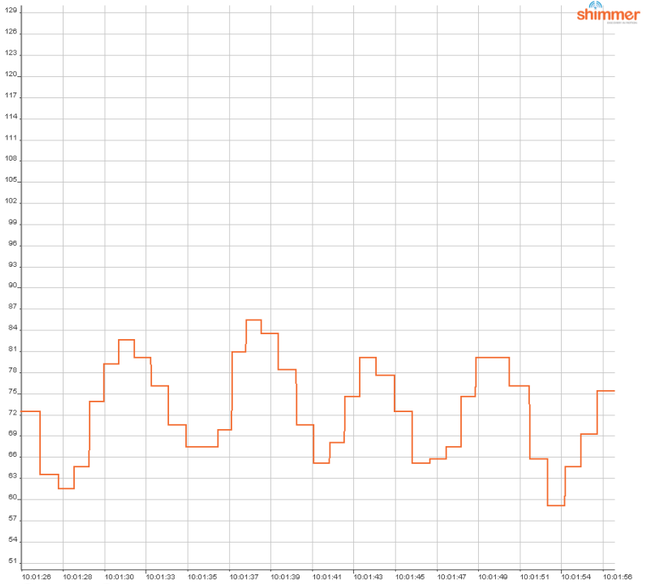
To test if the outcome of the product so far fits the wishes of the client, we organized another user test at Bascule. During this user test the small-scale model of the room, the pillow and the cube were taken to show how the room would be changed to the users’ preferences.

To do actual tests with the users when they are stressed and need the room was not possible. Mainly because their situation at these moments of severe stress is that critical that it would not be humane or morally correct to let them perform certain tasks for a user test. Therefore, we just sat down with a group of adolescents and therapists, showed our ideas and talked about it. We let them interact with the pillow and the control panel.

The main feedback was that the pillow was really nice because with the blue light it looked a bit like a cloud which they found really calming. They thought that it would be nice if the frequency of the pulsing could also be modified individually because then they could find their own ideal tempo. They really liked the buttons and sliders we used on the control panel. They found



Graph 1



Graph 2

them satisfying and playful which was our aim. They found it important that it took very few steps to set the room to your own preferences. When they are very stressed, they certainly do not want to have to take a lot of steps to be able to de-stress. Our control panel sufficed in that regard.

To actually test whether the breathing coaching of the pillow works, we conducted a user test on other students. They are in the same age category as some of the visitors at Bascule. We started by measuring the heart rate of each person. We saw that there were minor fluctuations and a healthy number of beats per minute (BPM). The next step was showing a video that simulated the life of an autistic person. This video contained a lot of stimuli. The average BPM's of the test person did not necessarily increase but started to fluctuate more (graph 1). We gave the pillow to the tester and said that he had to breathe together with the lights in the pillow for about 3 minutes. When they did this, their heart rate dropped to a lower, but still healthy heartbeat (around 65 BPM). The most impressive result with all the users was that a sinus pattern arised (graph 2), that relates to the speed of the breathing. Therefore, we concluded that the pillow works.

Final product

After going through all stages of our design process we made the final design of the chill out room. The arrangement of the room will be as shown in the 3D model earlier in the report, but the other artifacts the room contains will be explained in more detail below.

Control Panel

The control panel is a playful cube that enables the user to set the chill out to their own preferences. The design of the control panel is based on a fidget cube. This is a sort of dice with different shapes and mechanisms on each side where the user can interact with when stressed. Because the purpose of these cubes is to be able to relieve stress in a playful way, we thought this design would fit the purpose of the control panel. The cube contains 4 sides the user can interact with:

Topside: the top side is for controlling the color of the light in the room. As mentioned before, we chose the five colors which are proven to have the calmest and positive effect on humans [2][7][11]. The user can choose to light up the room blue, green, yellow, white or purple by pressing on the belonging button. The buttons have the same color as the belonging light which makes it easy to navigate.

Front side: the front side consists a slider which adjusts the brightness of the light in the room. The icons next to the sliders indicate what the action does. Up is brighter and down is less bright. In this way, the user can create the right ambiance in the room, and at the same time, it enables the user to take the amount of light through the windows into account.

Left side: the left side also contains a slider which is meant to turn the pulsing function of the pillow on and off. The user may not want to use the pillow all the time. When they have calmed down and don't need the pillow anymore, but still want to use the room before they get back into the stress of daily life, the pulsing may just be an annoying provocation. That is why it is important that the user has the choice to turn it on or off.

Right side: the right side of the cube contains two big buttons. With the help of these buttons, the user will be able to navigate through the pictures displayed on the wall by a beamer. The left button is for going back in the series of pictures, the right for going forward. This enables the user to choose what picture makes him feel calm and comfortable in the room, which will help them in the process of getting calmer.

Things we especially focussed on while making the control panel was the playfulness and satisfaction of the interaction. The sliders and button must look inviting to interact with and be satisfying while using. This is important because we want our user group to feel as comfortable, positive and safe as possible when they are making use of the chill-out room. Another aspect which was considered as very important is that it must take very little steps to set the room to your preferences. The user group is very stressed in the situation when the cube is used. Therefore, it would be annoying and stressful when changing the settings of the room would take a lot of time or would be difficult. Every side will only need one action of the user to set it to their preference. Only the buttons for the visuals may need to be pressed more than once. During the user test at Bascule the subjects confirmed that the control panel was playful, satisfying and easy to use. To be able to demonstrate the control panel we created a scale model of the room in which we implemented a led strip.

Technical aspect: Inside the fidget cube is an Arduino Uno connected to a breadboard. Via the breadboard, the Arduino is connected to the two potentiometers (the sliders) and seven buttons. On the Arduino, all the different options of the control panel are programmed in a way that the different functions do not get in each other's way. For example, when you change the intensity of the light this will automatically happen with the already selected color. For the visuals, the cube is connected to a laptop which is connected to the beamer. In a real setting, the cube would directly be connected to the beamer via Bluetooth. The whole circuit, code and other details can be found in the appendix.

Pulsing Pillow

The pulsing pillow is a tool that the user of the room coaches to lower their stress levels. To be more precise, it coaches them to breathe in a certain breathing pattern of 12 breaths a minute. Following this calm breathing tempo will lower stress levels and help the user to calm down [3]. The pillow is just an ordinary pillow without a pillowcase (or with a somewhat translucent one) with blue led lights in it. This color is chosen because research showed that blue and green are a calming combination, green is already present in the room so the color of the pillow is chosen to be blue. These led lights pulse with a frequency of 0,2 Hertz which glow and fade the pillow. This makes the pillow look a bit like a cloud which creates a cozy ambiance. The user can interact with the pillow in multiple ways. He can just look at it, but also hold it (preferred during user tests) or lie upon it. The user then looks at it and tries to follow the pattern of the pulsing lights with his breathing. In this way, the stress level will lower, and the heart rate will form a constant pattern, as can be seen in our user tests. The pillow can be switched on an off via one of the sliders on the control panel as mentioned above.

Technical aspect: Inside the pillow, there is a small box with a teensy board. On the teensy is an Arduino code to make an RGB led strip pulse with blue light with a frequency of 0,2 Hertz. Via a breadboard, the teensy is connected to the digital RGB led strip with a length of 1 meter. The led strip goes out of the box and goes through the pillow in a way that the light is well divided over the pillow. The circuit is powered by a power bank in the box. For the full circuit and the Arduino code see appendix.

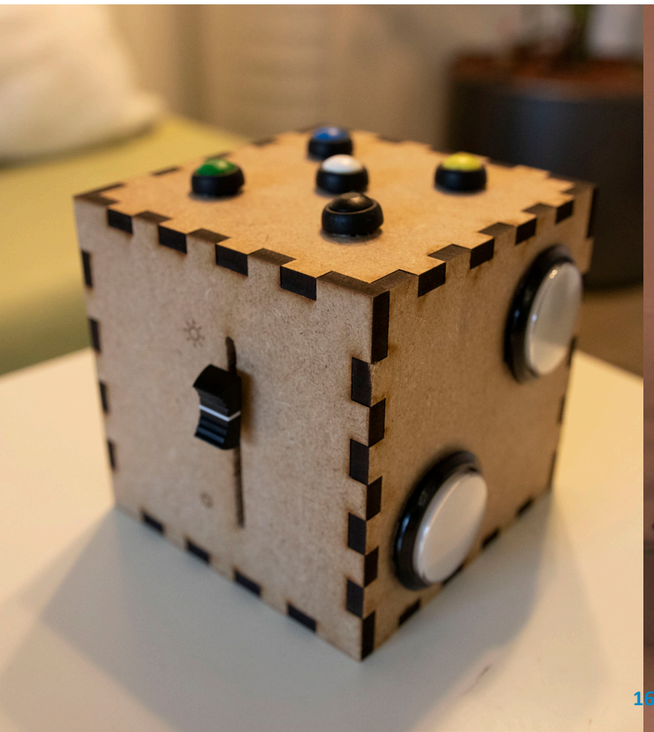
Bio-Feedback

The object in the room that gives the user biofeedback is again inspired by the design of a fidget cube. Three sides of the cube are usual fidget cube sides, one contains a led and another one contains a heart rate sensor. The user can just fiddle with the three normal sides, but if he wants to use biofeedback to calm down he can put his finger on top of the sensor. The user does not have to put on any equipment which might feel clinical to do and will also be very annoying when stressed. They just have to put their finger in the middle of the side of the cube containing the sensor and their heart rate is measured. The feedback is where the led comes in. When the measured heart rate is below 85 bpm, which is a normal value, [14][5] the led will turn green. In this way, the user knows he is doing well and is getting calm again. This knowledge will give some confidence and will benefit the further process of getting calm [13][12]. When the bpm is between the 85 and 95 the led will turn blue. This will indicate the user that he/she is getting calmer, which will put their minds at ease. When the measured heart rate is above 95 bpm, which is in stress [14][5], the led will be off. We chose to give only positive feedback by not showing a red light. This will have a better effect on the user because negative feedback may only cause more stress “Kernis, Brockner, and Frankel (1989) argued that low self-efficacious people are more likely to react to negative feedback by experiencing negative affect, exhibiting less motivation on a subsequent task, and attributing the feedback less to effort and more to ability”[15]. Therefore, we thought a positive approach would be better for our target group.

Technical aspect: In an extra case underneath the fidget cube an Arduino Uno board is placed. This board is connected with the heart rate sensor and the led and is programmed to let the heart rate sensor measure the heart rate of the user every x seconds. The analog output of the sensor sends a signal that accords to your heart rate. The Arduino reacts to that signal by turning on the led in a certain color or turn the led off. In the appendix, you can find the circuit and other technical details of the biofeedback.

Advice to client

The assignment of this project was to design a room to let the patients of bascule 020 calm down. The outcome of this project advices on how to redesign the room, how to use technology in the room and an indication of the costs of this. The amount of costs is €1673,62. However, it is possible that bascule can arrange other deals with companies as it is a company and those deals happen between companies. On what this is based can be found in the appendix.



Future steps

Looking at the future and the received feedback from demo-day and user tests, our design could still have some iterations. One of the things that still can be improved to further personalize the room is the pulsation tempo of the pillow. This is now set to 12 breaths per minute, but not everybody is completely comfortable with this tempo. For some people, it is a little bit too slow and for others too fast. Therefore, another function could be added to the control panel. A function that makes the user able to variate the tempo of the pillow between for example 11 breaths per minute to 13 breaths per minute. In this way, the pillow could be used more comfortably because it will cost the user less effort to follow the tempo. This will, of course, have a positive influence on the process of calming down.

Another aspect that can have some further development is the connection between the control panel and the pillow. This must be done with a Bluetooth device, which was too expensive for now.

The last future step is to start a company that provides the services to multiple health organizations. For more insight towards that, see appendix.

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Appendix

Interview Psychologist

She works just like the bascule 020 institution with short time consultations. However, she has and talks a lot to colleagues that work with in a Clinique, where this happens more often.

She's a psychologist that works with children with trauma's and with children of the same age category as we work with.

They are using games to make children calm. They can only continue with the game when they get calm.

She says that own preferences in the room are important. Some like animals, some like landscapes. Having your own preferences in the room is good for the visitors. She likes our idea of using the projector with animals.

The general thing all members have, is that they have multiple problems. Stress is in almost all cases an effect of this and they can not have a lot of stimuli.

The problem with visuals can be that you create a lot of stimuli.

The beautiful thing about having a room that can be changed to your own preferences is that you can avoid stimuli. If you don't like animals, then do not choose animals. If you do not like green, then do not choose green lights, etc. Another good thing can be that they learn what they need to get a step further (calm).

Our idea of pre selecting images and colors (to prevent stimuli) is good.

She REALLY likes biofeedback. Sometimes, you and physical in good shape children come in, but with a heart rate of 140 BPM or maybe even 40 BPM, just because they are really stressed. Usually they do exercises with her to calm her down. With the biofeedback we want to implement in the room, they can immediately see that their heart rate is way too high/low and try to adopt to that.

Advice to client

Redesign of the room €987,25

The looks of the room should be as mentioned above in the 3D model, simple with symmetry and nature. This can be done with the following budget estimate:

Furniture €605,71

Couch – €399,00 https://www.ikea.com/nl/nl/catalog/products/S59205293/

Fat boy- already in possession

Table – 2 * €5,99 https://www.ikea.com/nl/nl/catalog/products/20011413/#/20011408

Guitar- €89,95 https://www.bol.com/nl/p/western-gitaar-hoogglans-zwart/9200000019417148/?suggestionType=suggestedsearch&bltgh=qkqrL-xOt9gRsAGxKyhDDw.twyf2tHQGTKgNdYysZtCTQ_0.1.ProductTitle

Poster of nature €104,78 https://www.fotobehang.com/dennenbos.html

Floor €381,54

Laminate- €32,20 p/m2 = 4,10 m*2,89 m*€32,20= €381,54 https://www.praxis.nl/verf-

laminaat-decoratie/vloeren/pvc-vloeren/cando-comfort-click-kunststof-vloer-lichtgrijs-eik-2-21m²/5541271

Technology €686,37

The device that we designed is not finished for production. The alternative that we offer the client is to use a Philips hue and a beamer. The pillow is not replicable for another option. The budget estimate is:

Philips hue:

Ledstrip €71,99 https://www.bol.com/nl/p/philips-hue-white-and-color-ambiance-

lightstrip-plus-2-m-wit/9200000053328422/ suggestionType=browse&bltgh=j8D7dZlW-7jyX-MaKzZxLLg.1.2.ProductTitle

Bridge €49,99 https://www.bol.com/nl/p/philips-hue-bridge-

eu/9200000051668820/?suggestionType=browse&bltgh=gLUigBNN9g5-gm-l-cRGwA.1.9.ProductPage

Beamer. The beamer should have enough lumen so it can be used in rooms with different light intensity. The beamer should be able to work with Bluetooth, therefore a Bluetooth toggle is implemented.

Beamer should have short throw-technology (have a big screen from little distance)

The beamer in the link below has this short throw-technology and has a luminous flux of 4000 to 5000 lumen.

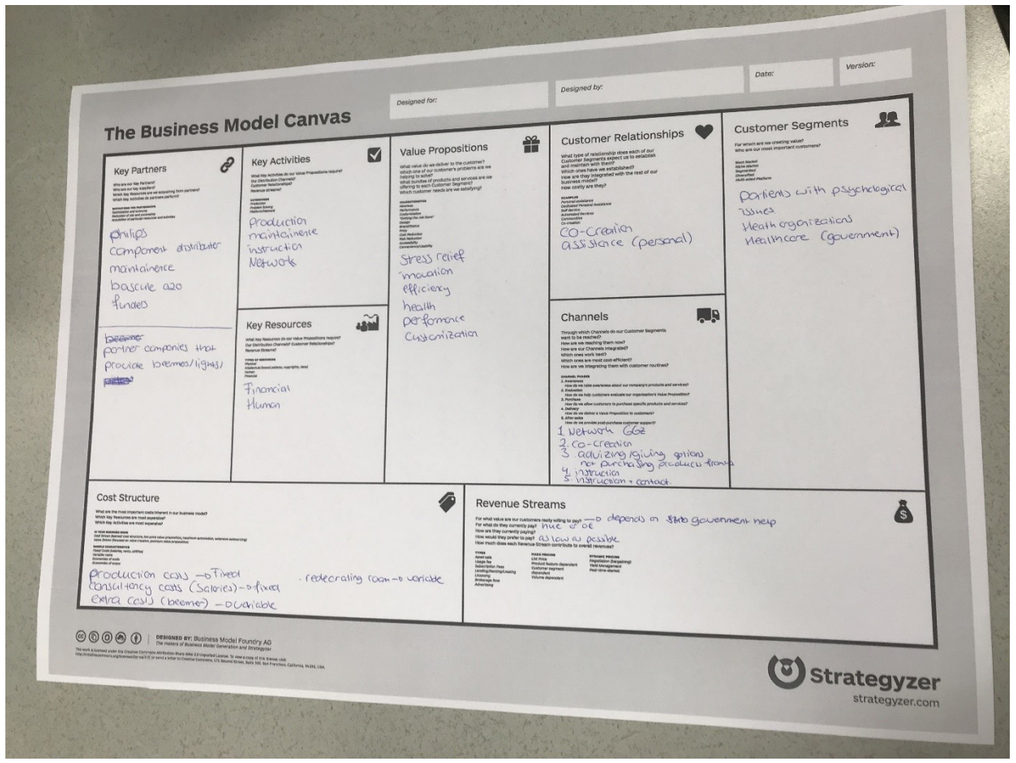
€558,14 https://www.bol.com/nl/p/infocus-in2126x-beamer/9200000069314449/?suggestionType=typedsearch&bltgh=mVhMt7MgmADqdf0QsmVJdg.lMMkdm-9XJn7C13qsbhNFg_0.1.ProductTitle

Bluetooth toggle €6,25 https://www.bol.com/nl/p/mini-bluetooth-4-0-usb-

adapter-dongle-audio-receiver-transmitter/9200000089646608/?suggestionType=typedsearch&bltgh=mt1ydIMCWdYLBDQpSh5OsQ.1.6.ProductTitle

Business model canvas

To get an idea how the product could be brought up on the market a business model canvas was made. This model was based on the idea that multiple organizations can use the technology that we have developed.



From this business model it became clear that only part of the room can be from our product. The service that we are going to deliver is a consultancy, we deliver a standard service and some optional extra options:

What we deliver standard:

- Advice

o 3D model of the room

o Standard functions of the room

- Control panel
- Instruction

Extra optional costs:

- Beamer
- Lights
- Room decoration

o Luxe or budget

- Pillow

Extra fixed costs:

- Maintenance

The process will go as followed:

1. We visit the client, explain the options, client chooses options
2. Prepare the 3D model and a quotation
3. Visit the client, show the model and explain the quotation
4. Client choses if they agree with the quotation and chose final options. The client buys optional extras from external parties.
5. We deliver the control panel and, when chosen, the pillow. During this visit instructions for the control panel are given to the staff.
6. Maintenance is available for problems.

Other insights from the business model canvas are that subsidy has to be taken into account when designing a product for a health organization. This is very relevant for the costs of the product but cannot be taken into the calculation right .

Pictures

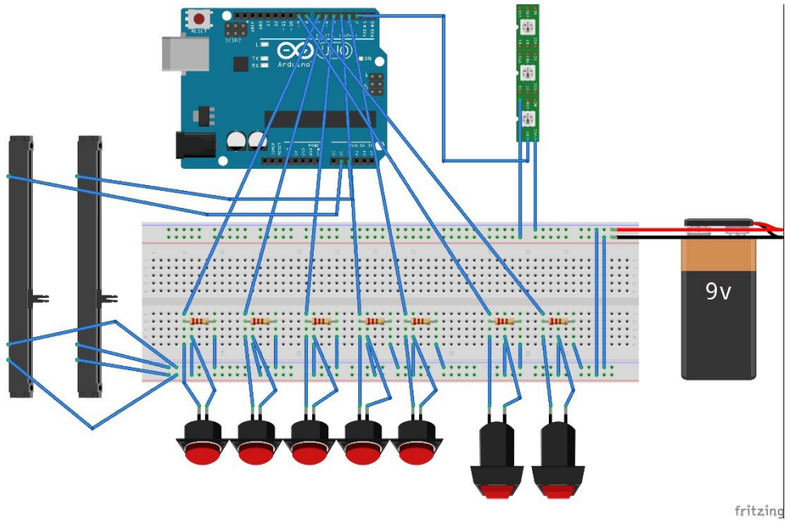
Technical aspect Control Panel

Used components:

- Arduino Uno
- Breadboard
- 10k ohm Slide potentiometer 2-channels – 60 mm (2x)
- Green pushbutton 12mm – reset – PBS – 33B

- Blue pushbutton 12mm – reset – PBS – 33B
- Yellow pushbutton 12mm – reset – PBS – 33B
- Black pushbutton 12mm – reset – PBS – 33B
- White pushbutton 12mm – reset – PBS – 33B
- Big White Pushbutton 24mm- reset
- 10k resistors
- WS2812B Digital 5050 RGB LED Strip – 60 LEDs 1m
- Wires

Circuit:



Code:

Light


```
#include <FastLED.h>
#define LED_PIN 2
#define NUM_LEDS 28
#define TWO_THIRDS_PI 2.094
#define TWO_HUNDRED_PI 628
CRGB leds[NUM_LEDS];

const int buttonPin1 = 3;
int buttonState1 = 0;

const int buttonPin2 = 4;
int buttonState2 = 0;

const int buttonPin3 = 5;
int buttonState3 = 0;

const int buttonPin4 = 6;
int buttonState4 = 0;

const int buttonPin5 = 7;
int buttonState5 = 0;

int i = 0;

bool blue = false;
bool green = false;
bool white = false;
bool yellow = false;
bool violet = false;

int brightness = 0;

int treshold = 500;

int val1 = 0;
int val2 = 0;
int val3 = 0;
int val4 = 0;
int val5 = 0;
int val6 = 0;
int val7 = 0;
int val8 = 0;
int val9 = 0;
int val10 = 0;
int val11 = 0;
```

```
void setup() {
Serial.begin(9600);
FastLED.addLeds<WS2812, LED_PIN, GRB>(leds, NUM_LEDS);
  pinMode(buttonPin1, INPUT);
  pinMode(buttonPin2, INPUT);
  pinMode(buttonPin3, INPUT);
  pinMode(buttonPin4, INPUT);
  pinMode(buttonPin5, INPUT);

}

void loop() {

   //pulsing lights
   Serial.println(analogRead(A1));
   if (analogRead(A1) < treshold){
for(int i=0; i<TWO_HUNDRED_PI; i++){
        val1 = round(18/2.0*(sin(i/100.0)+1));
        val2 = round(72/2.0*(sin(i/100.0)+1));
        val3 = round(110/2.0*(sin(i/100.0)+1));
        val4 = round(62/2.0*(sin(i/100.0)+1));
        val5 = round(120/2.0*(sin(i/100.0)+1));
        val6 = round(56/2.0*(sin(i/100.0)+1));
        val7 = round(124/2.0*(sin(i/100.0)+1));
        val8 = round(127/2.0*(sin(i/100.0)+1));
        val9 = round(85/2.0*(sin(i/100.0)+1));
        val10 = round(65/2.0*(sin(i/100.0)+1));
        val11 = round(128/2.0*(sin(i/100.0)+1));

        delay(4);
  brightness = map(analogRead(A0), 0 , 1024, 150 ,0);
  FastLED.setBrightness(brightness);
  if(blue == true){
        for (int x =0; x <28; x++){
     leds[x] = CRGB(val1,val2,val3);
  }
FastLED.show();
  }

  brightness = map(analogRead(A0), 0 , 1024, 150 ,0);
  FastLED.setBrightness(brightness);
  if(green){
        for (int x =0; x <28; x++){
     leds[x] = CRGB(val4,val5,val6);
  }
FastLED.show();
  }
```



```
  brightness = map(analogRead(A0), 0 , 1024, 150 ,0);
  FastLED.setBrightness(brightness);
  if(white){
        for (int x =0; x <28; x++){
     leds[x] = CRGB(val7,val7,val7);
  }
FastLED.show();
  }

  brightness = map(analogRead(A0), 0 , 1024, 150 ,0);
  FastLED.setBrightness(brightness);
  if(yellow){
        for (int x =0; x <28; x++){
     leds[x] = CRGB(val8,val8,0);
  }
FastLED.show();
  }

  brightness = map(analogRead(A0), 0 , 1024, 150 ,0);
  FastLED.setBrightness(brightness);
  if(violet){
     for(int x =0; x <28; x++){
     leds[x] = CRGB(val9,val10,val11);
  }
FastLED.show();
  }

if (digitalRead(buttonPin1) == HIGH){
  blue = true;
  green = false;
  white = false;
  yellow = false;
  violet = false;
}
if (digitalRead(buttonPin2) == HIGH){
  blue = false;
  green = true;
  white = false;
  yellow = false;
  violet = false;
}
if (digitalRead(buttonPin3) == HIGH){
  blue = false;
  green = false;
  white = true;
  yellow = false;
  violet = false;
}
if (digitalRead(buttonPin4) == HIGH){
  blue = false;
```

```
  brightness = map(analogRead(A0), 0 , 1024
  FastLED.setBrightness(brightness);
  if(violet){
       for(int x =0; x <28; x++){
    leds[x] = CRGB(85,65,128);
  }
FastLED.show();
  }

if (digitalRead(buttonPin1) == HIGH){
  blue = true;
  green = false;
  white = false;
  yellow = false;
  violet = false;
}
if (digitalRead(buttonPin2) == HIGH){
  blue = false;
  green = true;
  white = false;
  yellow = false;
  violet = false;
}
if (digitalRead(buttonPin3) == HIGH){
```

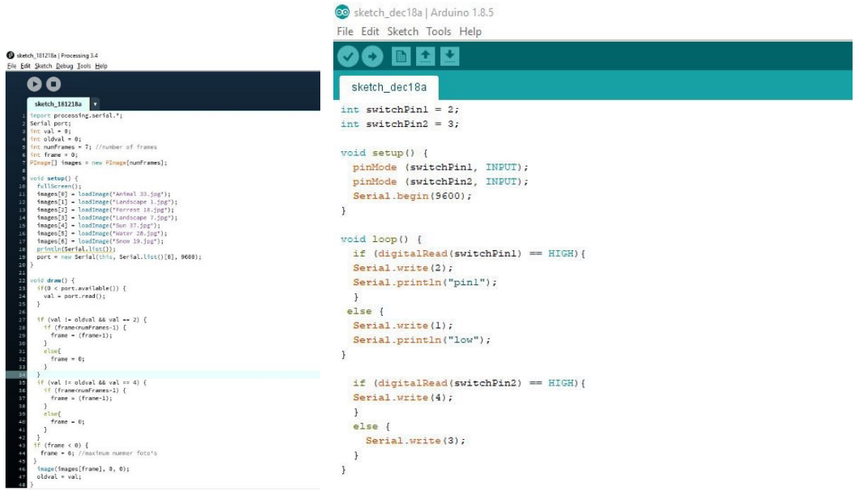
Visuals

```
  green = raise;
  white = false;
  yellow = true;
  violet = false;
}
if (digitalRead(buttonPin5) == HIGH){
  blue = false;
  green = false;
  white = false;
  yellow = false;
  violet = true;
}
}
    }
if(analogRead(A1) > treshold){
//normal light
  brightness = map(analogRead(A0), 0 , 1024, 150 ,0);
  FastLED.setBrightness(brightness);
  if(blue == true){
        for (int x =0; x <28; x++){
    leds[x] = CRGB(10,72,110);
  }
FastLED.show();
  }

  brightness = map(analogRead(A0), 0 , 1024, 150 ,0);
  FastLED.setBrightness(brightness);
  if(green){
        for (int x =0; x <28; x++){
    leds[x] = CRGB(62,120,56);
  }
FastLED.show();
  }

  brightness = map(analogRead(A0), 0 , 1024, 150 ,0);
  FastLED.setBrightness(brightness);
  if(white){
        for (int x =0; x <28; x++){
    leds[x] = CRGB(124,124,124);
  }
FastLED.show();
  }

  brightness = map(analogRead(A0), 0 , 1024, 150 ,0);
  FastLED.setBrightness(brightness);
  if(yellow){
        for (int x =0; x <28; x++){
    leds[x] = CRGB(127,127,0);
  }
FastLED.show();
  }
```

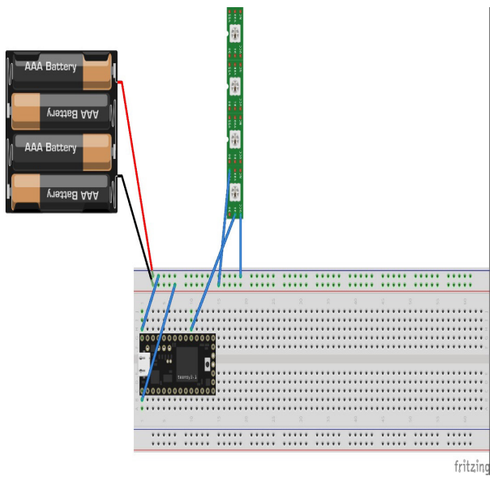


Technical aspect Breathing Pillow

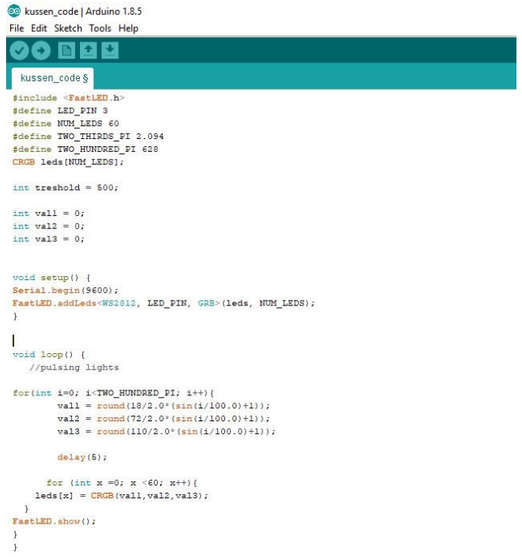
Used Components:

- Teensy 3.2
- Breadboard
- WS2812B Digital 5050 RGB LED Strip – 60 LEDs 1m
- Power bank
- Wires

Circuit:



Code:

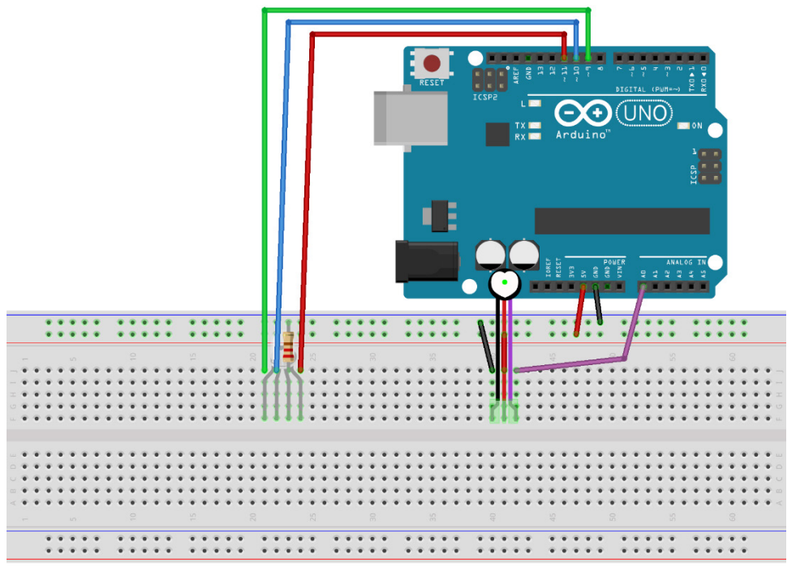


Technical aspect Bio Feedback

Used components:

- Arduino Uno
- Pulse sensor
- RBG led
- Resistor
- Wires

Circuit:



Code:

hartratesensor.2 §

```
//Heartrate measuring code from: https://pulsesensor.com/pages/getting-advanced
//an RBG led is used instead of an RGB
//--------------------------------------------------------------------------*/

#define USE_ARDUINO_INTERRUPTS true    // Set-up low-level interrupts for most acurate BPM math.
#include <PulseSensorPlayground.h>     // Includes the PulseSensorPlayground Library.
#define COMMON_ANODE
//  Variables
const int PulseWire = 0;       // PulseSensor PURPLE WIRE connected to ANALOG PIN 0
const int LED13 = 13;          // The on-board Arduino LED, close to PIN 13.
int Threshold = 550;           // Determine which Signal to "count as a beat" and which to ignore.
PulseSensorPlayground pulseSensor;  // Creates an instance of the PulseSensorPlayground object called "pulseSensor"
int redPin = 11;               // set the red pin of the RBG led to PIN 11 on the arduino
int greenPin = 9;              // set the green pin of the RBG led to PIN 9 on the arduino
int bluePin = 10;              // set the blue pin of the RBG led to PIN 10 on the arduino

void setup() {
  Serial.begin(9600);          // For Serial Monitor

  // Configure the PulseSensor object, by assigning our variables to it.
  pulseSensor.analogInput(PulseWire);
  pulseSensor.blinkOnPulse(LED13);       //auto-magically blink Arduino's LED with heartbeat.
  pulseSensor.setThreshold(Threshold);

  // Double-check the "pulseSensor" object was created and "began" seeing a signal.
   if (pulseSensor.begin()) {
    Serial.println("We created a pulseSensor Object !");  //This prints one time at Arduino power-up,  or on Arduino reset.
  }
  pinMode(redPin, OUTPUT);  // set the redpin as an output
  pinMode(greenPin, OUTPUT);  //set the greenpin as an output
  pinMode(bluePin, OUTPUT); //set the bluepin as an output
}

void loop() {
 int myBPM = pulseSensor.getBeatsPerMinute();  // Calls function on our pulseSensor object that returns BPM as an "int".
                                               // "myBPM" hold this BPM value now.
if (pulseSensor.sawStartOfBeat()) {            // Constantly test to see if "a beat happened".
 Serial.println("♥  A HeartBeat Happened ! "); // If test is "true", print a message "a heartbeat happened".
 Serial.print("BPM: ");                        // Print phrase "BPM: "
 Serial.println(myBPM);                        // Print the value inside of myBPM.
}

if(myBPM<85){                                  //if myBPM is lower than 85 the green pin will turn on
  analogWrite(greenPin, 255);
}else{                                         //if myBPM is not lower than 85 do not turn on the green pin
  analogWrite(greenPin, 0);
}
if(myBPM >85 & myBPM <90){                     //if myBPM is between 85 and 90 turn on the blue pin
  analogWrite(bluePin, 255);
}else{                                         //if myBPM is not between 85 and 90 do not turn on the blue pin
  analogWrite(bluePin, 0);
}
  delay(20);                                   // waity 20 ms until new loop
}
```