

# RELAX-CHANGE: A Physical, Expressive and Multi-sensory Drum Tool Changing The Perspective on Relaxation for People With High Levels of Anxiety

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## ABSTRACT

We are living more and more in an inclusionary world, in which people with all kinds of differences are accepted and offer a source of inspiration to society. However, people with elevated trait anxiety, aged 18-35 years old, experience expressions of worrying and rumination, meaning streams of negative thinking which restricts in daily life functioning, disabling them to be their 'best self in society' decreasing empowerment and social integration. This causes a high need of support in relaxation for this target group. The designed creative drum tool RELAX-CHANGE, is focused on providing a novel physical, expressive and multi-sensory perspective on relaxation and support for this target group. RELAX-CHANGE, provides the opportunity to build up towards a point of full physical and multi-sensory expression in drum play (highlight in play) to flow from there into relaxation (release). In this work, the design of RELAX-CHANGE is presented and highly qualitative online evaluation methods including two focus groups, with in total 7 participants, and 1 expert interview, with an expert from the field of clinical psychology. It was found that in general, RELAX-CHANGE has the potential to support in relaxation and is expected to have positive relaxation effects due to its underlying principles and engagement potential of specific design aspects.

## Author Keywords

Elevated anxiety; relaxation; relaxation support; tangible design; playful interaction; multi-sensory design; musical objects

## INTRODUCTION

We are living more and more in an inclusionary world, in which people with all kinds of differences are accepted, feel included and offer a source of inspiration and knowledge to others around. However, people in special need groups are often restricted in daily life functioning, making them unable to be their 'best self in society' and so feel less empowered and integrated into society (Alper, Hourcade & Gilutz, 2012).

Anxiety disorders are the most prevalent mental disorders currently (21st century) which cause very high healthcare costs and a large affectedness in society, "33.7% of the population are affected by an anxiety disorder during their

lifetime."(Bandelow & Michaelis, 2015, p.1). As in adults, anxiety disorders are the most common type of mental disorders with a 12-month prevalence of rate of 24.9% (Bandelow & Michaelis, 2015). Anxiety includes a spectrum of many types amongst which general anxiety disorder (GAD), panic disorders, social anxiety disorder (SAD) and specific phobias having their commonalities in daily life limitation (Bandelow & Michaelis, 2015).

In society that there is undertreatment and underrecognition of this type of mental health issues (Bandelow & Michaelis, 2015, p.1). This lack of visibility of anxiety disorder restricts participation in daily life causing a powerless feeling and a sense of being out of control (Sanchez & Kunze,2018). Unawareness and misunderstanding of anxiety and its symptoms amongst the target group themselves and stakeholders; temporal periods of anxiety and difficulties with (social) performance are the main problems enhancing this powerless feeling on a daily base. Related to this, to create empowerment and social integration amongst people within the anxiety spectrum, a specific problem can be addressed being the lack of relaxation in common daily life context (Borkovec & Costello, 1993). This is especially relevant for people with elevated trait anxiety, related to general anxiety disorder, which is most prevalent in the age group of 18-35 years old (Bandelow & Michaelis, 2015). Namely, people with elevated trait anxiety experience expressions of worrying and rumination, meaning streams of negative thinking, either future-or past-oriented, difficult to control (Greeson & Brantley, 2009) which causes tiredness and a decreased self-image (feeling of incompetence) which highly asks for a need of support in relaxation (Borkovec & Costello, 1993).

One of the most effective methods, superior to medication, is cognitive-behavioral therapy (CBT) in which cognitive, emotional and physical responses to worrying and rumination are identified and addressed through i.a. relaxation training (Greeson & Brantley, 2009). From a design perspective in the mental health sector that is anxiety reduction related, playful interaction design has tried to offer support within this widespread anxiety spectrum. Especially, potential is seen in the field of "gamification" for mental health and serious games because of its improved engagement potential through game-based dynamics

(Fleming et al, 2017). However, both psychological methods and designs are mainly focused on soothing distraction which does not suffice for everyone to break their anxiety cycles (Knaus,2014); are mainly digital, neglecting the potential of physical design; offer therapeutic treatment instead of being support to therapy; and neglect the potential to offer stimuli affecting all three responses to worrying and rumination. Therefore, in combination with the multi-sensory benefits to physical engagement in creative musical tasks, through physical multi-sensory objects, potential is seen for expressive, multi-sensory and physical qualities in design as an opposed perspective on support in relaxation for this target group.

In this work the design of a creative drum tool RELAX-CHANGE, including physical, expressive and multi-sensory aspects, and three highly qualitative evaluation methods are presented. The design focuses on support in the build up towards a point of full physical and multi-sensory expression in drum play (highlight in play) to flow from there into relaxation (release). In this way, it is researched, what the potential effect is of building up towards an expressive, multi-sensory and physical highlight in play, through the use of a (home-based) creative and multi-sensory object on perceived relaxation and perceived support amongst adolescents and adults (18-35 years old) with elevated trait anxiety, as defined by the trait/state anxiety inventory (Spielberger,1983).

Evaluation methods consist out of two online iterative focus groups (n=3, n=4) and one online expert interview with prof.dr. Julian Rubel, expert on treatment efficacy in therapy contexts.

Through a group of 7 participants, and 1 psychotherapy expert, in general, potential of the design of RELAX-CHANGE for relaxation and support in relaxation is found, just as positive expected effects. This is based on certain underlying design principles, RELAX-CHANGE has, that are valued by the participants, as *low engagement barriers*, *“useful tension”*, *physical activity/mind-body workouts* and *distraction*. Moreover, results show that ‘recognizability’ of the drum, ‘freedom’ in building up towards the highlight in play and the element of ‘fun’ in crescendo building led to a positive potential for engagement in the design, and so for support in relaxation. However, the emphasis in discussing the boundaries of the potential of RELAX-CHANGE for relaxation and relaxation support is in the multi-sensory aspect of the design, about which participants express various design improvements.

This work contributes a physical, expressive and multi-sensory object RELAX-CHANGE, that provides a novel perspective on relaxation and support in relaxation for people with elevated trait anxiety, a problem of societal concern. A detailed reasoning behind the design, and the design research process is provided which can be used as basis for future work on support in relaxation for this target group. Novel insights about the potential of the design for relaxation and

support within this target group are offered, just as insights about future design iterations, future design research and the role of this type of design in uncovering new space in clinical practice.

#### **RELATED WORK**

In order to establish the context and approach for creating a novel perspective on support in relaxation, this section covers three main areas. In the first area current approaches for relaxation for the target group are discussed well-known in the field of psychology. Secondly, the field of playful interaction designs for well-being and anxiety will be introduced. Third, the area of physical designs and musical objects for anxiety is described, showing the potential of physicality, expressivity and multi-sensory engagement for support in relaxation in this target group.

#### **Approaches for relaxation from the field of psychology**

In order for people with elevated trait anxiety to overcome moments of negative thinking, standard methods for therapy include psychotherapy and medication (Greeson & Brantley, 2009). Because of the mind-body nature of anxiety, effective treatment strategies focus on addressing mental and physical functioning in anxiety situations. One of the most effective methods, superior to medication, is cognitive-behavioral therapy (CBT) in which disturbing thoughts (cognitive), negative emotional reactions (emotional) and inflexible behavior (behavioral) are identified, corrected and re-structured focusing on self-monitoring and relaxation training (Greeson & Brantley, 2009). However, methods that think the other way around, and directly reduce these cognitive, physical and emotional responses to support relaxation are sparse, but effective (Knaus, 2014). Therefore methods, focused on the creation of relaxation, including stimuli directly tailored at reducing the multi-faceted responses might be a promising approach to support in relaxation. Moreover, relaxation training in CBT often includes soothing methods, amongst others progressive muscle relaxation, breathing training, creative visualization and imaginary techniques, as distraction and engagement in other consuming tasks than their thought processes (Knaus, 2014). Another interesting modern movement focuses on principles from mindfulness, emphasizing on acceptance of experienced inner cognitive, emotional and physical states during moments of worrying and rumination (Greeson & Brantley, 2009). People with elevated trait anxiety often narrow the focus of their attention inwards which increases their discomfort (Greeson & Brantley, 2009). Therefore, practice of mindfulness has the advantage of creating awareness of this focus in attention and supports in accepting the situation to create mind-body connection. However, these soothing approaches for either distraction or acceptance while being absorbed in a consuming task, do not suffice for everyone to break their anxiety cycles (Knaus,2014). This offers therefore potential for contrasting relaxation methods focused on expression and creativity.

### **Design for well-being and anxiety**

From the perspective of design in the mental health sector that is stress or anxiety reduction related, playful interaction design has tried to offer support within this widespread anxiety spectrum. Especially, potential is seen in the field of “gamification” for mental health and serious games (Fleming et al, 2017). This because of its improved engagement potential through game-based dynamics (Fleming et al, 2017). A systematic review of CBT-based serious games and gamification often made use of absorption in fantasy environments or positive psychology as ‘level ups’ to increase engagement in therapeutic programs (Fleming et al, 2017). Other examples of this type of games, include Above Water, a digital-tangible hybrid game educating individuals about coping strategies for Generalized Anxiety Disorder and Panic Disorder (Wehbe et al, 2016); or Flair, a therapeutic serious game for Social Anxiety Disorder (Sanchez & Kunze, 2018). It can be seen lots of these designs are digital and focused on therapeutic processes. But what about physical design and a non-therapeutical form of playful interaction, to support next to relaxation or after therapy processes? One of the designs most related to offering this kind of physical support in relaxation is proposed in a paper by Park, Hu and Huh about plant-based games for anxiety reduction (Park, Hu & Huh, 2016). As a physical, organic interface plants provided a novel way to produce emotional connectedness and mutual care to relax and reduce anxiety. Compared to the psychological methods, this design was especially focused on stimuli for overcoming emotional responses to anxiety, but still not covered support for all. Furthermore, also in these design solutions a focus is on soothing designs for relaxation which increases the motivation for research on expressive designs in this field.

### **Physical designs and musical objects**

Non-soothing and physical designs, for distraction and absorption in consuming tasks, include creative music engagement such as musical instruments and objects. Music engagement enables to reconnect with the world around, connecting thoughts and emotions (Wilkins et al, 2014). Next to that, it provides opportunities for relaxation, improved mood and creates stress reduction (Hallam, 2010). Furthermore, music engagement has major contribution in the development of self-identity, increasing self-esteem and competence (Hallam, 2010), which could be an extra benefit next to relaxation. In this way individual music engagement can provide a physical outlet for negative thinking, creating possibilities to reset, relax and benefit from increased self-esteem amongst people with elevated trait anxiety. Therefore, interactive musical (instrument) objects can enable these advantages in people with elevated trait anxiety (non-musicians) through easy access, intuitive and responsive user interfaces (Wu & Bryan-Kinss, 2017). Furthermore, these have the ability to offer stimuli affecting all three responses to worrying and rumination, offering a multi-sensory experience. In this way physical engagement in creative musical tasks, through multi-sensory objects, can

help to decrease emotional states through musical mood management; decrease body tension through physical activity and distract from thought process stimulating the multiple senses. This shows potential for an opposed perspective on relaxation, as compared to the soothing methods and designs, of expressive, multi-sensory and physical qualities in design.

### **METHODOLOGY**

To explore the potential of expressive, multi-sensory and physical design for support in relaxation for this target group, an iterative design research process has been applied (Appendix B, Process Visualization). This process was centered around both background research and evaluative methods.

#### **Iterative design research process**

This process consisted of two phases, 1) background research, and 2) evaluation / iteration, which were performed in three iterations. Emphasis in phase 2, was on the evaluation of the design and its underlying principle using qualitative methods as focus groups and an expert interview. Below, both phases, methodologies, study instruments and analysis procedures are explained in more detail.

#### *Phase 1: Background Research (iteration 1, 2)*

The first phase was centered around background literature research, ideation, conceptualization, expert interviews and creation of the final design and prototype. In the first iteration, the main goal was to investigate the target group, their needs in relaxation support and design research scoping by evaluating four novel design concepts with two experts in the field of clinical psychology and research (prof.dr. Julian Rubel and dr. David Rosenbaum). In the second iteration, the goal was to create a novel final design and prototype to evaluate in the focus groups and final expert interview.

#### *Phase 2: Evaluation / Iteration (iteration 3)*

The second phase consisted of final iteration 3. In the first place, before the COVID-19 crisis, the evaluation approach was centered around a comparative and controlled quantitative experiment, in which the effect of RELAX-CHANGE on the relaxation measures and perceived support would be measured. However, due to an extra vulnerable target group because of COVID-19, the final evaluation was centered around a highly qualitative approach. In this way, the design research focus was shifted to researching the potential of RELAX-CHANGE for relaxation and support for still the same target group, including potential effects.

The two iterative focus groups (n=3, n=4) were centered around the discussion of daily anxiety situations; the design and underlying principle; and its potential effects. As probes for discussion, three ‘video probes’ were used. Participants were recruited based on convenience and heterogeneity. The general population was targeted, but within the age group of 18-40 years old, including healthy consenting adults still suiting the target group’s age group. Their level of anxiety was anonymous and only evaluated after the focus groups had been taken place, for research analysis. This to link the

group's anxiety diversity to the qualitative answers related to the designed (video) prototypes.

The expert interview was conducted with prof.dr. Julian Rubel (n=1), from the field of clinical psychology, University of Giessen in Germany. He is an expert in research on treatment effects in therapy contexts, and was also involved in iteration 2. This interview was focused on the discussion of the design, its underlying principle and the role of design in clinical practice to frame future work. In this discussion, only one of the three 'video probes' was used, focused on the design of RELAX-CHANGE.

### Study Instrument 1 – RELAX-CHANGE

#### Background Research

A combination of the novelty of creative music engagement for people with elevated trait anxiety and insights from literature about the main problems of this target group, resulted in the first four concept visualizations. Insights from literature, showed the main problem of this target group was with negative thinking, and their multi-faceted responses to this (cognitive, physical and emotional). In combination with the potential benefits of creative music engagement, to provide outlet for negative thinking and support in the multiple responses and self-competence development, it was aimed to design for physical and multi-sensory distraction, creating absorption in a creative and musical activity. Each of the first four concepts focused on a different distraction approach, 1) Multi Drum focused on expressive physical outlet as distraction, 2) Manipulatable Jewellery focused on a soft fiddling outlet to focus attention outwards, 3) Discovery focused on outside musical discovery, connecting the mind to the physical world, and 4) Draw Thoughts centered around multi-sensory drawing/writing as a way to structure emotions and thoughts and offer musical distraction. In the two inspirational expert interviews with dr. David Rosenbaum and prof.dr. Julian Rubel, Multi Drum and Manipulatable Jewellery were concluded to have most potential to be novel, effective and tailored for the target group and relaxation.



Figure 1: visualized concepts of Multi Drum (left) and Manipulatable Jewellery (right)

In the second iteration, a more novel perspective in multi-sensory support was found that led into the investigation of the Multi Drum design direction. Because current supportive methods and tools for relaxation, often not cover

expressivity and multi-sensory experiences which are important to address to support a larger part of the target group to break anxiety cycles, the direction of physical multi-sensory expression was further explored. This resulted into three new concepts differing in the spectrum of expression offered. 1) Clover Drum focused on intense freedom of expression, in which a free multi-sensory play area was offered, 2) Drum Pad focused on a more intuitive form of expression, in which a variety of multi-sensory drum pads were offered, and 3) Artistic Drum focused on more symbolic and soft forms of expression, in which multi-sensory "clouds" could be created. In order to be able to research the most novel perspective related to multi-sensory expression, overwhelming design aspects in concept 1 were discarded, just as the soothing design elements as in concept 3, resulting in the choice for the Drum Pad concept to further detail in terms of physicality, multi-sensory, and expressive aspects.



Figure 2: visualization of Drum Pad concept

Through literature research on musical theory and musical tension and release creating aesthetic experiences and influencing human's emotion (Fredrickson, 2000), explorations of how this could support multi-sensory expressiveness in the design and support in emotional responses to worrying and rumination were done. In this way, the main principle of the final design was found, called Tension and Release.

#### Final design and prototype

Based on the background research the final design and prototype of RELAX-CHANGE was made. With the final design it was aimed to evaluate the novel perspective of its underlying Tension and Release principle, as part of multi-sensory expression, just as its physical, multi-sensory and expressive aspects to find out the potential of the design and principle for relaxation and support in relaxation for the target group.



*Figure 3: the final design of RELAX-CHANGE*

In general, RELAX-CHANGE, is designed for support in relaxation at home for people with elevated trait anxiety, finished with therapy or for use as support next to therapy. The design has three underlying principles from which the main one is the ability of the target group to create Tension and Release with the drum, which will be explained later in more detail. The first principle underlying the design is that this creative drum allows for engagement in a distractive and consuming task. Distractive and consuming tasks are often used as part of cognitive behavioral therapy, to create relaxation amongst people with high levels of anxiety (Greeson & Brantley, 2009). The second principle is related to Tension and Release, which means the design supports in building towards a point of full physical and multi-sensory expression in drum play (highlight in play), through multi-sensory feedback provided in the drum. In this way the building up towards this highlight in play or so called multi-sensory and expressive crescendo (tension), supports in overcoming the negative thinking, and flow from there into relaxation (release). The final principle underlying the design is to offer support in overcoming the multi-faceted (cognitive, physical, emotional) responses to negative thinking through provided multi-sensory feedback in the drum.

Its design features contain multi-sensory feedback in the form of musical and light feedback mechanisms that support building towards the highlight in play. The musical feedback helps creating musical tension (Fredrickson, 2000) as support. Within the principle of musical tension and release it is chosen for harmonic tension and release, using harmonic tones for two reasons (E,2019). On the one hand, harmonic tones can create tension in multiple ways compared to other forms of tension and release (e.g. rhythm), through a dissonant combination of tones after each other in play and through the play of a tension tone over a non-tension tone which is held on for a while. On the other hand, harmonic tones have more potential to elicit positive emotional response countering the emotional response to worrying/rumination. Therefore, it is chosen for musical tones within a G-scale, which sounds “happy”, even when tension is created, to counter negative emotional response and support in expressive engagement. The G is offered in the drum as central tone, and the D as subdominant tone and are therefore both 2 times offered as tongues in drum (and wider, more dominant), to move towards release of tension. The other tones: C, E, A, B are used to create tension over the G-tone, since they are not in the same triad as G and so differentiate (and therefore all presented as the smaller tongues).

Moreover, the light feedback visualizes the “most touched drum pads”, or in other words the current state of with which pads it is tried by the person to build up towards the crescendo, which supports in leading towards optimal multi-sensory expression. When certain drum pads are touched

“most often” compared to other ones, over a certain time period, the light underneath those pads glow warmer (red-ish). To show that with these pads it is tried to build up towards a crescendo. On the other hand, when these “most touched drum pads” are not touched for a while, their light glows colder (blue-ish).

In this way, a combination of musical tension release and light feedback mechanisms, together with the shape of the design and its drum pads, the design allows for a variety of ways to build up towards the highlight in play. This to suit the variety in expressive styles of the spectrum of people in the target group. As design researcher, ways of crescendo building were imagined as varying in musical tension release and play intensity, or a combination of continuous musical tension and high play intensity which the design could have guided the users into. However, for the research purpose and novel perspective in support it is focused on supporting users to lead towards a crescendo themselves instead of “following” fixed play patterns.

This design has been prototyped to function in the ‘design video’ probe for the final evaluation phase on which will be reflected in the ‘Individual Reflection’ in Appendix A and visualized as a process in Appendix B, Process Visualization.



*Figure 4: The prototype of RELAX-CHANGE*

#### **Study Instrument 2 – Video Probes**

Due to COVID-19, the two focus groups and the expert interview were conducted in an online environment. In combination with the fact, it was not managed to combine the prototype functions, ‘video probes’ were made to support in discussing general relatedness to daily anxiety situations, the design and underlying principles (Appendix H, Video Probes). For explaining daily anxiety situations a ‘scenario video’ was used; for the design a ‘design video’; and for its main underlying principle a ‘wrap-up video’. During focus groups all three video probes were discussed. The expert interview was focused on discussing the design, its principle and integration into clinical practice for which singularly the ‘design video’ was used as support.

#### *Scenario Video and purpose*

This video explains the scenario of a master student who goes to university on a daily basis and examples of the different ways he could encounter anxiety in his everyday

life. These examples of daily anxiety encounters from which was expected the focus group participants could relate to or reflect on included, 1) Corona crisis in general, 2) Writing an important paper for a conference, 3) Not able to catch sleep at night, 3) Having to go on the bus, and 4) Watching the news on television.

#### *Design Video and purpose*

The design video explains the main goal of the design to build up towards a multi-sensory and expressive crescendo and the ways to do so by explaining the multi-sensory features to discuss afterwards. Furthermore, it shows a variety of examples of elements the participants or expert could have used to build up towards a crescendo, when provided with the functional prototype, to engage them with the prototype interactions in discussion. These examples included, 1) Play interaction using slight musical tension, 2) Play interaction using huge musical tension, 3) Increasing intensity in play using the “most touched pads”, and 4) Varying intensity in play using others than the “most touched pads”.

#### *Wrap-up Video and purpose*

This simple video explains the main principle of Tension and Release, underlying the design, just as an example of a daily context of use. This example shows a general moment of anxiety after a long day and the use of RELAX-CHANGE at home right before bed time. In this way, the video offered support in discussing underlying principle and design context.

#### **Study Instrument 3 – Self Reported Questionnaire**

In both focus groups participants were asked to fill in the State-Trait Anxiety Inventory (STAI) (Spielberger, 1983), a self-reported questionnaire to gather data about their general (trait) and state anxiety levels (Appendix G, State-Trait Anxiety Inventory). In this way, quantitative scores to items from the State-Trait Anxiety Inventory were gathered, in other words self-report data. This inventory consists out of statements related to State anxiety (S) and other ones related to Trait anxiety (T). Both scales have anxiety absent and anxiety present questions. Anxiety absent questions represent the absence of anxiety in a statement like, “I feel secure.” Anxiety present questions reflect the presence of anxiety in a statement like “I feel worried.” These self-reported data was obtained via Excel Sheets from the Microsoft Forms the participants filled in, listing the self-reported answers to the 40 items in a 4-point frequency scale. The link to the questionnaire in Microsoft Forms can be found in Appendix G, State-Trait Anxiety Inventory.

#### **Focus Groups and Expert Interview**

This final evaluation was centered around a highly qualitative approach and was fully conducted online, via online video conferencing technology Microsoft Teams. In both focus groups as the expert interview, qualitative online methods were central, however in both focus groups it was made use of quantitative STAI methodology to be able to select qualitative discussion responses representable for the

target group. In this way, the potential of RELAX-CHANGE for relaxation and support just as potential effects could be evaluated.

Online focus groups were found an appropriate method to use because it would allow the participants, with potential elevated anxiety levels, to feel comfortable and safe while participating in open and honest discussion. While it might be discussed there are limitations in natural discussion possibilities conducting the focus groups via an online environment, study instruments and discussion topics have been adapted to get most out of it.

The expert interview with prof.dr. Julian Rubel was found appropriate as evaluation method, based on his involvement in the former design research phase and his expertise in treatment effects, just as his view on integration of design in clinical practice.

For both focus groups and the expert interview the approach was based on the methodology as described by Krueger (Krueger & Casey, 2015) and was adapted to a more elaborate form fitting this research. For the expert interview, semi-structured questions were added to the discussion set-up related to the role of design in clinical practice. The research was approved by the ethical board of the University of Technology in Eindhoven (Appendix M, ERB Form).

#### *Participants*

##### *1. Focus Groups*

For these focus groups 7 participants were recruited, in 3 in group 1 (n=3) (P1,P2,P3), 4 in group 2 (n=4) (P4,P5,P6,P7) aged between 20 and 25 years old. The first group consisted of 1 male, 2 females, the second out of 4 females. In these focus groups the general population was targeted. As such only people without clear intellectual or physical disabilities are solicited for this research. For general psychological research pertaining to playful interaction, only healthy consenting adults, within the age group of 18-40 years old, were recruited to participate. In order to fulfill the criteria of consenting adults, each participant was informed about the research and its purpose upfront and was asked to sign a consent form to either give consent to participation or not and to what extent regarding audio recording and publication of data. In this specific COVID-19 situation it was especially emphasized on recruiting technology capable participants, who were able to work with video technologies. Moreover, the participants for the focus groups were recruited based on convenience and heterogeneity. Their level of anxiety was anonymous and only evaluated after the focus groups had been taken place, during the analysis. This to link the group’s anxiety diversity to the qualitative answers related to the designed (video) prototypes. It was chosen to recruit heterogeneous groups of participants, in terms of difference in study, gender and musical background. Since, this would spark more diverse interaction amongst participants and would encourage participants to look from multiple perspectives to the presented (video) prototypes and so be

better able to give valuable insights. Therefore, in group 1 consisted of TU/e Industrial Design students, containing 1 non-musician, 1 keyboard player (beginner), 1 piano/guitar player (advanced). In the second group, there were two TU/e Psychology and Technology students, one TU/e Lucid board member and one TU/e Industrial design student having a gap year. Here, 2 non-musicians, 1 singer/guitar player, 1 piano/guitar player/singer (advanced) were present. Exclusion criteria: 1) participants without consent, 2) participants who fall out of the age group of 18-40 years old, 3) participants with severe mental states or issues, and 4) participants that are currently in therapy for anxiety related issues.

## 2. Expert Interview

This interview was conducted with prof.dr. Julian Rubel, researcher in the field of psychotherapy and clinical psychology at the University of Giessen in Germany. He is an expert in research on treatment effects in diverse therapy contexts. For this interview researchers within the field of clinical psychology or clinical practitioners related to the context of worrying and/or rumination, which he fits. For general psychological research pertaining to playful interaction, only healthy consenting adults were allowed to participate. In order to fulfill the criteria of consenting adults, the expert was informed about the research and purpose upfront and asked to sign a consent form to either give consent to participation or not and to what extent regarding audio recording and publication of data. In this specific COVID-19 situation it was especially emphasized on recruiting a technology capable expert, who was able to work with video technologies. Exclusion criteria: 1) participants without consent, 2) participants with severe mental states or issues, 3) experts outside the field of clinical psychology, outside the field of psychology and clinical practice or outside of the context of worrying and/or rumination.

### Procedures

As mentioned above, procedures for all three studies were based on methodology as described by Krueger (Krueger & Casey, 2015) but tailored to online methods and the particular circumstances and aspects of this research. Handouts of both focus groups and expert interview can be found in Appendix F, Evaluation Protocols. Consent forms can be found in Appendix E, Consent Forms.

### 1. Focus Groups

Both focus group sessions consisted out of an introduction (welcome, purpose, why invited, guidelines (which were already made clear in the consent forms upfront of the focus groups), roles clarification, introduction of participants). After introduction, there was a phase to fill in the state-trait anxiety inventory and ask questions about it. This was followed up by the most important stage, a 3-phase-discussion in which the 3 video probes were used, discussion topics were prepared just as open-ended questions as in a semi-structured interview. These Discussion topics after the

‘scenario video’ included relatedness to daily anxiety situations presented and experience with current relaxation methods and tools. Topics to discuss after the ‘design video’ included first impressions, interactions, musical tones, light feedback and shape. Finally, discussion topics after the ‘wrap-up video’ consisted out of future use and possible effects. Both sessions were closed with a closure phase in which final questions could be asked, oral summary was given to the group and final reactions could be given. Each focus group lasted for approximately 60 minutes. During the focus groups, the researcher functioned as both moderator and note taker, but was supported by audio recordings, for which consent was given by all participants.

## 2. Expert Interview

The expert interview consisted out of three phases. These could be described as an introduction (welcome, introduction of participants, purpose, why invited, guidelines (which was already made clear in the consent form upfront of the expert interview), roles clarification). After this, a 2-phase discussion was introduced in which the ‘design video’ probe was discussed using specific discussion topics, prepared open-ended questions as in a semi-structured interview and a semi-structured interview with open-ended questions regarding opinions on bringing design into clinical practice and the role of physical, expressive and multi-sensory design in therapeutic contexts. Regarding the design and its underlying principles, the same discussion topics as in the focus groups were used. The interview was closed with a closure phase (final questions, oral summary to the participants & reactions on that, thank you and goodbye). Moreover, the expert interview lasted for approximately 90 minutes. During the interview, the researcher functioned as both moderator and note taker, but was supported by audio recordings, for which consent was given by the expert.

### Analysis

The analysis procedure consisted out of a combination of quantitative and qualitative analysis for both focus groups and qualitative analysis for the expert interview.

### STAI / Quantitative Measurements

Analysis was done for each participant by scoring the 40 items, of the filled in STAI, based on the answers in the 4-point frequency scale and the corresponding scoring weights to their responses. The total score of each participant showed their level on the state-trait anxiety spectrum, for both state anxiety (S) as trait anxiety (T). Scores for both levels of anxiety could range from 20 to 80. Low scores indicate a mild form of S or T anxiety, median scores indicate a moderate form of S or T anxiety and high scores indicate a severe form of S or T anxiety. In order to present results that represented the target group best, the total S and T scores of the participants were scanned to find ‘outliers’ in the data. When a participant scored above 60 on T anxiety this participant was selected as ‘outlier’ in the data, matching with the level of ‘elevatedness’ in anxiety of the target group. Furthermore, if a participant scored remarkably low on either

S or T anxiety, this participant was also selected as 'outlier' in the data.

#### *Focus Groups and Expert Interview / Qualitative Measurements*

Procedure followed when analysing the qualitative focus groups and expert interview data was based on note-based analysis as described by Krueger & Casey (Krueger & Casey, 2015). In this procedure the moderator, in this case the researcher, prepared written notes based on summarizing comments from both focus groups and expert interview, just as selected audio recordings. Further analysis of both focus groups and expert interview, separately, was done through thematic analysis methodology (Braun & Clarke, 2006). These consisted out of the following steps: familiarizing with the written data and audio data (transcribing), generating initial codes (interesting features of the data), searching for key insights (overlapping insights in the codes), reviewing key insights (check if insights work related to the abstracted codes), defining and naming key insights (specifics of each key insight), producing final report / results of each focus group and expert interview (what does it mean, interpretation). After combining the key insights from both focus groups and the expert interview, overall final themes were created to describe the potential of the design's principles, design's elements and the role of design in clinical practice. For the formation of the final themes, the discussion comments of the participants that had 'outlier' STAI results were especially taken into account to represent the target group. Qualitative analysis procedures can be found in Appendix I, Thematic Analysis. Explicit STAI results can be obtained on request.

#### **RESULTS**

The results are based on a combination of the two focus groups, outliers in the STAI scores of the participants in these focus groups and an expert interview with prof.dr. Julian Rubel. In these focus groups the self-reported STAI was filled in and discussions were focused on daily anxiety situations, relaxation, the design including its underlying principles and integration of the design.

In the first focus group all participants showed trait anxiety 'sum' scores above 40 which means they can all be categorized as having 'elevated trait anxiety'. A very important notion here is the circumstances we are currently in with COVID-19 crisis. Two of three participants (P1, P3) in group 1 also had elevated state anxiety scores, above the 60, which are particularly interesting to look at during analysis. According to the total trait anxiety scores of each participant in focus group 2, it can be concluded all of the participants can be categorized as having 'elevated trait anxiety', having scored above 40 as well. Again, the COVID-19 circumstances are also applicable here and are critically taken into account reporting the qualitative discussion responses of the participants. One of the participants in focus group 2 (P6) remarkably had a very low state anxiety score, around the 20 which is particularly interesting to look at during analysis. However, an important notion here is the

fact this participant was very tired (as commented in the focus group) which could have resulted into this remarkable total state anxiety score. During the analysis of the combined focus groups and expert interview data, it is especially emphasized on discussion points and responses of the three participants with outliers in STAI scores (P1, P3, P6), just as on surprising and unexpected mentionings.

Results give insights into four sub themes around the theme of *relaxation and support* (i.e., relaxation requires discipline, personal relaxation preferences, relaxation effects, and design benefits), three sub themes around the theme of *design experience* (i.e., first impressions, design engagement and design improvements) and two sub themes around the theme of *design integration* (i.e., design context and use, and design in therapy contexts). Furthermore, participant quotes and key insights can be found in Appendix I, Thematic Analysis. Detailed STAI scores can be obtained through request.

#### **Perceptions of relaxation and support**

Three subthemes relate to experiences with relaxation in general and current relaxation methods; the fourth highlights imagined benefits of RELAX-CHANGE. All are of interest for the results and discussion of the design potential, allowing to reflect on the match between the participants' beliefs or needs related to relaxation and the approach taken in RELAX-CHANGE. Just as to compare their current relaxation experiences with their views on potential benefits and contribution of RELAX-CHANGE.

#### *Relaxation requires discipline*

It became clear participants had difficulties to relax or take time for relaxation methods in anxiety situations. One participant in group 2 stated to have difficulties actually performing and selecting relaxation tasks, *"It is really stupid but when I come home at 11PM I don't think like yes I'm gonna do yoga for half an hour but I think I just go straight into bed or I am gonna do Netflix for a while!"* (P6, G2). In group 1 responses were similar, but focused on maintaining relaxation routines, *"It is really difficult to maintain it (meditation routine) because you have this 30 minutes time taking, it is pretty hard to take 30 minutes time for it."* (P2, G1). Moreover, participants also stated to have difficulties finding the right relaxation support, *"I struggle with not being able to turn my stress off, struggle with relaxing."* *"When I want to relax I just take a whole day off."* (P1, G1). In both cases the participants were very much aware of their struggles with relaxation in general and maintaining relaxation routines, but still their problems remained in anxiety situations. This demonstrates the need for support in relaxation through a solution that offers low barriers to engage, without time barriers, on which can be relied in anxiety situations, where RELAX-CHANGE can contribute.

Opposingly, both focus group participants had also experienced positive effects of anxiety discarding their need for relaxation in certain anxiety situations. Participants in

group 1 focused on the need of anxiety or stress for productivity, "Sometimes even the anxiety helps me to get my work done." (P2, G1) and finding a balance in anxiety and relaxation, "If you have to pull an all nighter it is good to have stress because it gives you energy but if you are stressed the whole week it is not really nice." (P3, G1). On the other hand, group 2 focused on past experiences with anxiety which on the long-term helped them overcome similar daily anxiety encounters, "I did notice my stress levels for these GMM's decreased along the road when I got more experienced with them." (P6, G2). In this way the participants mentioned, a balance between useful anxiety and relaxation needs to be found over the long-term. These comments about balancing useful tension and relaxation demonstrate how the underlying principle of Tension and Release within RELAX-CHANGE has potential in supporting the target group in relaxation.

#### *Personal relaxation preferences*

Participants experienced and preferred support in relaxation in a variety of ways. When asked about experiences with current methods as meditation or mindfulness, some participants mentioned these work for them or displayed interest in them. Within both focus groups, participants stated to have positive experience with mindfulness or meditation, "I had a meditation app and I used to use that almost everyday, it felt pretty good." (P2, G1). Next to that, others had read about mindfulness or psychological flexibility but never really done it, "I have read literature (she showed a whole paper book) about psychological flexibility" (P3, G1). Moreover, a group 2 participant assumed to fail in this type of relaxation task, "I really have never done meditation or anything like that, I think I am not good in doing that." (P4, G2). This demonstrates, current calming methods are of interest but still have barriers for the participants to engage in, showing support potential for the playful RELAX-CHANGE design in which it is unable to 'fail'.

In both focus groups, participants mentioned to prefer different ways to relax, especially physical exercise or mind-body relaxation as yoga. One participant in group 2 stated about the importance of physical activity, "What helps for me is walking a round every morning and every evening before I go to sleep doing some running, or something else actively." "Just clearing my head without it being really meditation, more like distraction." (P5, G2). Referring to yoga as a way to physically and mentally relax, one participant in group 1 stated, "Yoga is a nice combination of being physical and calming down mentally" (P3, G1). These responses show the importance of physical activity, being active and mind-body workouts for relaxation and distraction. This is a key insight, as RELAX-CHANGE is designed for active physical distraction and so relaxation. Interestingly, participants in group 2, mentioned being physical is experienced as relaxing without having relaxation as prior goal, more for being fit or distracted. As stated by a participant in group 2, "So I try to do minimally 1 time a week

*stretching and yoga and sports but at the moment I think it is chill, but it's not that I go in it with the intention of being very mindful or being very relaxed. I go into it way more physically, like okay I am going to stretch now.*" (P7, G2). This is a key insight, as RELAX-CHANGE is designed with building up towards a highlight in play as main goal, having relaxation as an effect.

#### *Relaxation effects*

This sub theme presents the effects of these preferred active ways of relaxation. Participants in focus group 2, stated a positively experienced feeling of rest after physical activity, "I really find it very nice to do stretch yoga in the mornings because after that you really experience a feeling of rest." (P6, G2). Another participant stated, physical activity positively affected the mood, "For me sporting just makes me happier." (P4, G2). Furthermore, an interesting experience about the unconscious effect of mind-body workouts was mentioned, "The chill thing about yoga is that unconsciously you really get a clear head, more rested head, because the instructors really hammer on that so to say." (P7, G2). These quotes demonstrate the potential for the effect of RELAX-CHANGE, making use of physical activity and mind-body workout, on relaxation measures and mood management. Expert prof.dr. Julian Rubel acknowledged possible similarity in the effect of a 'mindful state' and stated, "I guess the time afterwards where you have that relaxation, that is the most resembling right, a mindful state potentially, at least the goal of a mindful state." Discussions about durations of effects can be found in Appendix G.

#### *Design benefits*

In both focus groups the participants mentioned potential benefits of RELAX-CHANGE, as it is in a similar way designed for active physical relaxation. One of the participants from group 2 appreciated the fact RELAX-CHANGE brings 'relaxation' to an activity, and stated, "I think it is nice you brought it to an activity instead of focusing on doing nothing cause that is just..." (makes detesting sound)" (P4, G2). Furthermore, the opportunity to build up tension with RELAX-CHANGE was appreciated, "I really like you can build up the tension in this drum" (P6, G2). In this way, providing tension build up and physical activity in the design, contributes positively to support in relaxation.

Furthermore, positive (short-term) benefits were predicted. Group 1 participants in particular expected positive short-term effects on mood after play, and stated, "I think you feel it." (P1, G1) and "It will make you happy, but fade away after a while, turning into a loop." (P2, G1). In addition to positive mood regulation and feelings, optimized play patterns during the use of RELAX-CHANGE could allow for positive benefits to relaxation. As stated, "When you have optimized your play, that is when you got the benefits out of it." (P1, G1) and "When optimized, you know what you need to do to reach a crescendo to optimally relax." (P2, G1).

Next to that, especially group 1 participants, acknowledged the potential for long-term benefits through engaging with

RELAX-CHANGE, but also critically stated design improvements for prolonging the effects focusing on habit formation, "*The effect could be long-term, but could last longer if you can make a habit out of it.*" (P2, G1). This idea of habit formation around RELAX-CHANGE is a key discussion point, which will be discussed in the following 'Discussion' section.

Key insights relate to RELAX-CHANGE's design potential for relaxation and support, through: 1) lowering engagement barriers in relaxation; 2) offering a balance in useful tension and relaxation; 3) allowing for physical activity, mind-body workout and distraction; 4) offering a highlight in play as prior goal next to relaxation; 5) imagined positive contribution of tension build up and physical activity; and 6) imagined positive benefits of optimized play patterns.

### **Design experience**

Here, focus was on first impressions, design engagement and design improvements. These are of relevance for stating the potential of the design for support in relaxation and for discussion of future work.

#### *First design impressions*

The first impressions of the design were positive. Participants of both focus groups used words as "playful", "inviting", "intuitive" and "interesting" to describe it. Interestingly, multiple participants in group 1 mentioned they wanted to touch and play the drum through their screens, while watching the 'design video'. These two participants mentioned to be appealed by the different multi-sensory feedback layers in the design, and started a discussion about which feedback layer made the design most inviting. It was clear different multi-sensory feedback layers appealed to different participants in terms of invitingness. The two participants stated regards the light, "*I want to touch it through the screen because of the light feedback*" (P2, G1) and regards the musical feedback, "*I wanted to touch it through the screen because of the music, which was most interesting, and appealed me to play it.*" (P1, G1). Another aspect of the drum that was mentioned in both focus groups is that the design reminded of existing drums or musical instruments. Participants in group 1 started a discussion about the consequences of this 'recognizing' aspect of the drum. Participants concluded that because the drum's recognizability, they experienced this design as intuitive and understandable, and stated, "*The drum reminds of existing musical instruments making it intuitive and understandable.*" (P2, G1) and "*These are also used for stress relief.*" (P1, G1).

Next to that, expert prof.dr. Julian Rubel and expert dr. Rosenbaum, both involved earlier in inspirational expert interviews, were impressed by the design and prototype. Interesting enough prof.dr. Julian Rubel immediately acknowledged the potential of the drum for this target group, and stated in an e-mail conversation "*I can imagine a lot of people who could benefit from this drum!*"

#### *Design engagement*

Moreover, both focus group participants were asked to imagine how they would build up towards a highlight in play with the designed drum. Especially in focus group 1, this led to enthusiastic discussions about ways to engage in drum play. From their discussion it was clear various participants would build up towards the highlight in play in different ways that personally suited them. Two of the group 1 participants agreed to see themselves building up the "crescendo" slowly, based on discovery of preferred musical tones, and stated, "*I would do slow speed until discovered the tones.*" (P1, G1) and "*I would first try to find soothing tones and after that play faster.*" (P3, G1). Surprisingly, this group's third participant made clear to do it totally different, making use of the expressiveness of the design. As stated, "*I would play wild all the time, from beginning on, go crazy with it, since it is so expressive.*" (P2, G1). While discussing the "crescendo" building within the design with expert prof.dr. Julian Rubel, he also clearly stated the importance of personal build up towards a "crescendo", for relaxation and support, stating, "*People need to be able to vary their pace up to the crescendo right.*" Another important aspect participants in group 1 mentioned with regards to engagement in play and "crescendo" building, was "fun", "*It is nice to just go crazy with it.*" and "*It is just fun to use.*" (P2, G1).

Furthermore, remarks were made about the relation between optimal flow creation and engagement in the design. One of the participants in group 2 stated, "*It would be nice to create a kind of flow with the drum instrument.*"(P6, G2). Moreover, expert prof.dr. Julian Rubel had similar thoughts on the importance of a "flow state" for engagement in the design and relaxation, and stated, "*So you are actively involved with the instrument, it takes some time I guess until you get into some flow state doing this and then the time afterwards you have that relaxation.*"

#### *Design improvements*

Both focus group participants and expert prof.dr. Julian Rubel were eager to discuss first design impressions and engaging design aspects, and also gave various suggestions for design improvement. Especially, ideas for improving the multi-sensory feedback to make the design more engaging and enhance its expressive quality. These were mainly centered around, *responsive light feedback, type of musical sounds, and depth in musical feedback.* Especially in focus group 1, suggestions were made about the responsiveness of the light feedback and different ways to improve. One of the participants stated about improving the light color fading mechanism to be more effective, "*If the light changes fast and fades away slowly after, it would make the light be more effective and noticeable.*" "*It would help to just go more crazy with it if it is brighter for a moment when touched.*" (P2, G1).

Most suggestions centered around the musical feedback, to increase its depth and intensity and to increase variety for mood management. Various participants in group 1

mentioned to enable to hold on musical tones longer or to have “louder” tones based on how hard the drum pads are hit. This could create a more complete interaction, *“Immediate feedback on touch gives a kind of confirmation of touch, making it a more complete interaction.”* (P2, G1). Particularly, in group 2 many suggestions were made about improving the musical feedback to allow for more expression. Participants mentioned that the sounds were still too mindful, limiting them in expression. As stated, *“For me it's a bit confusing what is the purpose because it is indeed a very mindful sound which doesn't really make me feel like oooh let's hit it.”* (P5, G2). One of the participants in this group stated a preference for including “hard” sounds in the drum, for more expressive interaction, *“Now you do have a little bit cute jingles sounds and not really the hard sounds.”* (P6, G2) and building up tension in the drum, *“I miss a little bit the hard drumming.” “That would for me add a lot in building up the tension!”* (P6, G2).

Moreover, suggestions were made about tailoring the musical sounds more towards the variety of moods these participants experienced during anxiety situations, *“Musical tones that work best for expressiveness and relaxation are very situation and person dependent.”* (P2, G1). One group 1 participant stated, *“Within anxiety you can still have different moods to tailor for. When being frustrated you need other tones for being expressive than when being stressed.”* (P3, G1). Within group 2, multiple participants recognized this phenomenon and discussed how different musical sounds could work. One participant from group 2 stated about this in detail, *“When I am really scared or nervous I would like to have something softer and when I am angry would like to have hard tones.” “And I think that's why the idea of having kits in which you can choose what vibe comes out of the drum when holding the same principle, but just that you have a bit more choice in what sounds come out of it.” “So it adapts more to your feelings.”* (P6, G2).

Analysis gave insight in positive attitudes towards the design and its expressive and multi-sensory aspects just as various ways participants can see themselves engage with the designed drum. Furthermore, it was realized design improvements can be made, especially regards multi-sensory feedback although this was appreciated, to make the design more engaging and enhance its expressive quality.

### **Design integration**

Discussing the design use and context, through the ‘wrap-up video probe’ it was focused on the various ways of use and future design integration possibilities. These are of relevance for stating the potential of the design for support in relaxation and for discussion of future work.

#### *Design context and use*

The three participants in group 1 discussed different moments to use the design, just as different purposes within the field of relaxation. These ranged from “a break after work” to “before bedtime”. Elaborate investigation can be found in Appendix I, Thematic Analysis. Related to use

frequencies, one of the group 1 participants states to expect a change in use frequency when optimized play, *“When you know how to optimally play, you will probably use it 1 time a day.”* (P2, G1). However, interestingly, expert prof.dr. Julian Rubel makes a contrasting statement about the ability of users to control the use frequency of the drum on their own, and states, *“People can also become addicted to using it, so they don't need to use it too often.”* and *“You need to control for this use.”*

Moreover, without asking, in every group already discussions were formed about this, expressing the desire for different forms of use. The participants from focus group 1 had an interesting perspective on other contexts of use, all centered around the value of connection. Participants in group 1, stated to see potential in use as a bonding exercise, for couples therapy or as connection to relaxation therapy. This will also be discussed in the next sub theme, the ‘Discussion’ section and Appendix G. Contrastingly, participants in group 2, mainly discussed to see potential using the design in public space, *“You could use it for example in the squad spaces with headphones so others are not interrupted by it so you can use it in public.”* (P7, G2).

#### *Design in therapy contexts*

The role of design in therapy contexts and clinical practice has been heavily discussed with expert prof.dr. Julian Rubel. Elaborate discussion about implications of his statements for future work will be discussed in the ‘Discussion’ section.

Prof.dr. Julian Rubel mentioned there was clearly a need for design in therapy contexts, to create a higher treatment efficacy, and stated that therapy is not always effective for everyone, *“It's not that therapy is effective for every patient right, lots of people drop out, don't respond you know.”* and so creates a need, *“So there is clearly a need even when the therapist don't, might not agree with that, so they need something.”* but that therapists are not always able to find the solution, *“But we don't know what it is so we do try different things out but yeah.”* That is where designs like RELAX-CHANGE can play a role.

Building on this need, prof.dr. Julian Rubel discusses the role for design to make information about patients usable for therapists. Because, at the moment, already biomarkers are used but therapists are not convinced because they cannot use the data that is produced by these measurements. Therefore, prof.dr. Julian Rubel especially sees a chance there for design, and stated, *“That is basically where I especially see design to make these things usable right!” “To build a I don't know a corset to make all this new information that we don't have about our patients usable.”*

Another valuable insight is the great resistance amongst therapists to integrate new measurement tools in clinical practice, as stated, *“Most of them are very convinced of what they are doing and even convinced they don't need anything but themselves to help people. So it is really important to be extremely sensitive to this issue.”* He mentioned, therapists

really have to believe the usefulness of new interventions, and stated, "So it really needs to trust something, that they think yes this is something very useful, we can't go there without this thing." Therefore, one of the potentials for future work with RELAX-CHANGE includes the research of therapist acceptance around this type of design. Prof.dr. Julian Rubel agreed and stated, "The moment you want therapists to engage with it you need their acceptance."

Concluding, different preferences in use and contexts next to a home context were found. Furthermore, a need for design in clinical practice, a role for design within behavioral measurements and a future for design research around therapy acceptance was elicited which will be discussed in the 'Discussion' section.

## DISCUSSION

Insights from both focus groups and expert interview with prof.dr. Julian Rubel are considered which elicited the potential of RELAX-CHANGE and its underlying Tension & Release principle for relaxation and support in relaxation for people with elevated trait anxiety. Does the solution have potential to follow? Where does it have potential (general), where not (specific design aspects)?

Investigating the general perception of the focus group participants on relaxation, support and design benefits, potential of RELAX-CHANGE for support in relaxation was found, just as positive expected effects. This was based on certain underlying design principles, RELAX-CHANGE has, that were valued by the participants, as *low engagement barriers*, "useful tension", *physical activity/mind-body workouts* and *distraction*. This is in line with the approach taken in the design and the aimed effect. Participants mentioned to have great difficulties maintaining relaxation with current meditation or mindfulness techniques in anxiety situations, or finding engagement motivation because they require discipline and they risk the chance to fail. This emphasizes, the general need for and potential of the playful and expressive approach in RELAX-CHANGE, showing it can offer relaxation support through low engagement barriers, without time restrictions, eliminating any fail ability. Moreover, the design could serve as a tool offering a balance in what participants called "useful tension" and relaxation demonstrating potential for the underlying principle of Tension and Release. Furthermore, RELAX-CHANGE allows for physical activity, mind-body workout and distraction which is found to be preferred by participants as support in relaxation. Next to that, surprisingly, enabling the build-up towards a highlight in play as prior goal with relaxation as effect, was in line with the participants' preference in relaxation support. Looking, at how participants were supported by this aspect, it was found RELAX-CHANGE can have potential to support them in taking initiative to do a 'relaxation activity' and so offer a 'relaxation effect' in a more unconscious manner. Related to that, principles of tension build up and physical activity were

explicitly imagined by the participants to positively contribute in support in relaxation and mood management.

Even though, design experience limitations, focus group participants could see themselves engage with the designed drum in various ways. Evaluating participants' and expert's perspectives on the design and its aspects, positive attitudes towards its expressive and multi-sensory aspects were found. Which is considered as a success, taking into account these are novel aspects regarding relaxation for this target group. Below, specific aspects of the design are considered, how they led to positive imagined engagement potential, relaxation and support potential just as boundaries in this design potential, including design improvements to be made. The three aspects of engagement, multi-sensory and expressiveness are addressed.

### **Multi-sensory feedback layers for engagement and expressiveness**

Aspects that made RELAX-CHANGE novel for relaxation were expressiveness, multi-sensory and physicality, and expected to lead to improved support in relaxation and multi-faceted responses to anxiety, through its engagement potential (Greeson & Brantley, 2009). Therefore, when discussing the potential of these specific design aspects, it is particularly focused on their perceived contribution to engagement in the design and so in relaxation.

The results show that 'recognizability' of the drum, 'freedom' in building up towards the highlight in play and the element of 'fun' in crescendo building led to a positive potential for engagement in the design. Next to that, the participants highlighted that they expected positive benefits to playing the drum, when optimized play patterns. The creation of a "flow state" with the drum tool is acknowledged by both focus group participants and expert prof.dr. Julian Rubel to be from importance to be optimally engaged in the design and have potential benefits for relaxation.

However, the emphasis in discussing boundaries of the potential of RELAX-CHANGE for relaxation and relaxation support is in the multi-sensory aspect of the design. It was found, participants perceived the design as "interesting", "intuitive", "inviting" and "playful" because they appealed to different layers in the multi-sensory feedback provided by the design. Participants wanted to play the drum through their screens while watching the 'design video' and differentiated between the light making it playful and the musical tones making the drum most interesting. This demonstrated the inviting qualities of both the light and musical feedback in the drum and their potential for engaging participants in relaxation support. On the other hand, it is important to mention that the various suggestions of the participants on the improvement regards multi-sensory feedback, to make the design more engaging and enhance its expressive quality, show the limitations of the design for relaxation and support potential. Explicit areas of improvement in design potential are centered around

*responsive light feedback, depth in musical feedback and the type of musical sounds.*

The light feedback was designed to show the user the current state in building up towards the expressive and multi-sensory highlight in play, through warm-cold color fading related to the ‘most often touched pads’, over time of use. This was expected to engage the user in play, supporting in overcoming negative thinking, focusing the attention outwards on the light (Greesson & Brantley, 2009). Although, this principle still holds, the slow color fading has questionable engagement potential. Brighter and more touch responsive light could enhance the drum’s expressive quality and engagement, *“If the light changes fast and fades away slowly after, it would make the light be more effective and noticeable, helping to just go more crazy with it.”* and so have more potential for relaxation and support. The musical feedback was designed to create harmonic musical tension and release for engagement in play, support building up towards a highlight, and support in overcoming emotional responses to worrying and rumination, which effects were expected to be in this line of thoughts (Greesson & Brantley, 2009). Although, the musical tension build up was appreciated, the participants perceived the musical feedback to be somewhat restricting in expression because of the “mindful sounds” provided in the drum, decreasing its engagement potential. Next to that, adding the ability to tailor the drum sounds to particular moods in anxiety situations could add up to improved potential for engagement, and improved support in overcoming emotional responses, in other words mood management abilities.

### **Limitations**

One of the most notable limitations in this design research is the ‘design video’ probe that had to be used during the focus groups and expert interview, due to the online study situation because of the current Corona crisis. Because of the use of a ‘design video’ to engage the participants and expert into the design, its interactions and underlying principle limited the ‘experiential’ quality of the prototype. Therefore, the moderator had to explain some specific aspects of the design as “tension and release” in a bit more detail, which had potential to bias results because of the researcher’s perspective brought into discussion. Furthermore, because of this limitation, discussion responses about the design’s novel elements were somewhat on the surface. Furthermore, there were limitations in the design of the prototype and its multi-sensory aspects, due to budget and technical knowledge available, as its relative “simple” musical tones and relative “easy” light interaction. In this way, certain depth in novel functions were not included. Therefore, quite some discussion was on improvement of the design and its multi-sensory aspects for engagement qualities. While, a higher budget and easier contact with technical experts (limited due to COVID-19), would have improved experiential aspects of the prototype, still multi-sensory aspects were appreciated for its potential to make the design “intuitive”, “inviting” and “playful”.

As already mentioned, the current COVID-19 crisis limited the ability to perform the optimal evaluation method, an controlled comparative experiment. Due to the shift to online, more qualitative, methods as focus groups and an expert interview, the design research results were restricted to stating design “potential” for relaxation and support. Furthermore, because the recruitment of participants within the “actual” target group was of great risk due to their extra vulnerability in an increase anxiety situation as the COVID-19 crisis, this caused limitations to results as well. However, despite the targeted general population within the focus groups, the STAI results did show all participants could be categorized as having ‘elevated trait anxiety’ and were in this way representable for the target group. This is good news, because it highlights the contribution their responses regards positive design potential for RELAX-CHANGE can make. Although, there are limitations, these also show great potential for future work.

### **Future work**

Analysis resulted into potential for future design iterations and future design research, opening up an uncovered space in clinical practice.

#### *Future design work*

Results show, focus group participants were aware of their difficulties with relaxation in general and maintaining relaxation routines, but still their problems remained in anxiety situations. This shows the importance of habit formation around relaxation methods and tools. In fact, potential for long-term benefits through engagement with RELAX-CHANGE, were expected by the participants when providing opportunities for habit formation, *“The effect could last longer if you can make a habit out of it.”*. Therefore, an important next step for RELAX-CHANGE would be to iterate on the design, enabling it to support in creating a ‘relaxation habit’.

Furthermore, an important discussion point regarding future design iterations for improved potential for relaxation and support, is enhancing the balance in “leading” (creativity) and “following” (guidance) when transitioning towards a highlight in play using RELAX-CHANGE. The current design was focused on support in “leading” towards a highlight in play, explicitly incorporating the expressive quality of the design as novel aspect for relaxation within this target group. Although, a focus on either “leading” or “following” in the design both have their challenges, focus group participants and expert prof.dr. Julian Rubel stated the importance of incorporating introduction and guidance in the design for novices and non-musicians. As expert prof.dr. Julian Rubel stated regards the overwhelming aspect of choosing what route to take towards a highlight in play for novices in play within this target group, *“I could imagine people could get a little bit overwhelmed. It is an easy task right but still you have to choose what to do, although there is some feedback that keeps you engaged right.”* Participants from the focus groups, already had suggestions for including

novices in play and discussed the use of “*provided play patterns to be able to start trying, instead of being thrown into the deep, being optional to use, keeping the self-expression element.*” (P4,G2). Therefore, further investigations into the transition phase between “following” and “leading” in crescendo build-up, would be insightful for the design’s support potential.

A final discussion point, especially raised in group 2, relates to offering support in awareness of anxiety. One of the participants mentioned having difficulties “*recognizing feelings of anxiety.*” (P4, G2). This same participants made suggestions for incorporating reflection elements as extension to the design and stated, “*If you would use it at home, you could couple it with a kind of app in which you can track your progress.*” “*So you can save the pattern you played and that you can put a note next to it like this is how I felt before, and this is how I felt after.*” “*So you get more insight in similar situations.*” (P4,G2). This might be a first next step regards reflection, as a supporting element in the design related to relaxation.

#### *Future design research and uncovered space in clinical practice*

Prof.dr. Julian Rubel clearly stated a need for design in clinical practice, to enhance treatment efficacy, and stated that therapy is not always effective for everyone, creating a need which therapists are not always able to fulfill. That is where designs like RELAX-CHANGE can open up an uncovered space in clinical practice in the future.

In the expert interview, potential was perceived for future work on a controlled experiment. Two potential directions were found worthy to proceed in the future, as identifying differences in treatment effects or identifying differences in the way these means can give access to patient’s behavior useful in therapy. A variety of control conditions were discussed to use in the former experiment, related to future design research. Control conditions having most similar principles as RELAX-CHANGE were above all progressive muscle relaxation (Greeson & Brantley, 2009) (similar in tension-release principle); mindfulness (similar in ‘mindful state’ as after effect); the play of bongos (similar in musical expressiveness); and any crescendo building physical activity, as in-home biking (similar in building towards a highlight of expression).

Moreover, expert prof.dr. Julian Rubel especially sees a chance for design in making participant’s behavioral information “usable” for therapists. Mainly, because it was found, current measurement tools as biomarkers do not offer optimal support for therapists in providing participant data. Therefore, future design research on the role for playful design in (quantitative) behavioral measures in therapy context would be very insightful.

Another valuable future research direction is researching diverse therapist acceptance around this type of expressive, multi-sensory, and physical design in various related therapy

contexts. Especially since, there is a great resistance amongst therapists to integrate new measurement tools in clinical practice, because “*therapists are convinced of what they are doing and even convinced they don’t need anything but themselves to help people*” it is therefore important as designer to be extremely sensitive to this issue, when integrating design into clinical practice. Therefore, to open up an uncovered space in clinical practice, therapists need to see clear reasons that they cannot go without this type of design, since “*they are the one who introduce that thing, who tell patients what to do with it.*” according to prof.dr. Julian Rubel.

#### **CONCLUSION**

In this paper it was found the main problems related to elevated trait anxiety, due to worrying and rumination, cause disruptions in daily life functioning. In this way this target group experiences a decrease in quality of life, well-being and so empowerment and social integration which needs to be addressed. Therefore, the high need for support in relaxation for this target group, was addressed. The rationale behind, the design of drum tool RELAX-CHANGE, changing the perspective on relaxation for this target group was described. RELAX-CHANGE provides the opportunity to build towards a point of full physical and multi-sensory expression in drum play (highlight in play) to flow from there into relaxation (release). In general, potential of the design of RELAX-CHANGE for support in relaxation was found, just as expected positive relaxation effects. This was based on certain design principles that were valued by the participants, as *low engagement barriers*, “*useful tension*”, *physical activity/mind-body workouts* and *distraction*. Moreover, results show that ‘recognizability’ of the drum, ‘freedom’ in expression and ‘fun’ in crescendo building led to positive potential for engagement in the design, and so support in relaxation. However, boundaries of the design potential emphasize improvements in the multi-sensory aspect of the design. The results allow to provide insights on the potential of a novel take on design to contribute to improved relaxation and support for this target group. It is highlighted how the underlying principle of Tension and Release, has positive potential for relaxation and how the multi-sensory design aspects make a first attempt to increase engagement potential for support in relaxation. Although, previous methods and design had successfully demonstrated benefits of distracting consuming tasks for relaxation, they did not suffice for everyone to break anxiety cycles due to their soothing or digital characteristics. Therefore, this paper is novel in proposing and demonstrating the potential of expressive, multi-sensory and physical design to improve relaxation and relaxation support in this target group. On a higher level, future design iterations, future design research and the role of this type of design in uncovering new space in clinical practice is provided. This to contribute to the potential to support a larger part of the target group in relaxation and create larger space for clinical practitioners to support this target group.

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## **Appendix A: Individual Reflection**

In this project I worked on a design research about a creative and supporting drum tool (with expressive, multi-sensory and physical qualities), RELAX-CHANGE, that changes the perspective on relaxation for people with high levels of anxiety. RELAX-CHANGE allows to build towards a multi-sensory highlight in expression, to flow from there into relaxation. In the first two iterations, insights were gained about the target group, anxiety problems, relaxation context and design qualities needed for relaxation, through the process, to realize the detailed RELAX-CHANGE design and prototype to propose a novel perspective on relaxation. Together with the final iteration, that i.a. included focus groups and an expert interview, it was aimed to find implications for designing for this target group, discuss potentials of RELAX-CHANGE for relaxation and perceived support, and report future design iterations and future design research opportunities.

When revising my goals for this project, taking the current COVID-19 into account, my priority was on growth within the areas of Technology & Realization, User & Society and Professional Skills. However, I also experienced unexpected learnings in Math, Data and Computing.

Because of my enthusiasm after programming a voice agent in M1.1 and to align with my vision, of UX designer, I wanted to take my programming and electronics skills to a more professional level. I wanted to create experiences with my interactive prototypes having the ability to offer a variety of user interactions with them (not just voice input). Therefore, with the COVID-19 crisis and online education, I wanted to enhance my tangible interaction realization skills, taking a professional stance in this, also because of its importance and relevance for designing for special need group contexts. To create tangible interaction I learned the importance of 'background processing' in programming the interaction flow, using Arduino. Next to that, I learned multi-sensory feedback plays a big role in tangible interaction to supporting user experiences. Therefore, I learned to program and electronically realize various multi-sensory feedback mechanisms based on touch inputs from the drum pads. Most valuable was that I learned to program these multi-sensory output functions (musical and light) using for me unknown electronic components or code e.g. auditory feedback (musical drum tones) through programming a micro SD card module or programming LED color fading through HSV values instead of RGB. As mentioned above, another important learning regards programming, includes 'background' programming for analysis of behavioral measurements in the experiential prototype. This to adapt to the user during interaction or to get insights about the user's behavior in playful interaction design research. In this project, I learned to store drum touch inputs from each of the 8 touch pads as touch frequencies based on user input. This gave me insights in other contributions that programming can have in design research, as supporting in evaluating user experiences, e.g. visualizing play patterns of people with high level anxiety. Discovering this new potential of programming made me enthusiastic to proceed with this in my project and include more behavioral measurements in programming in a follow-up prototype to evaluate in therapy contexts. Next to programming, I massively improved my electronic circuiting skills because of the use of unknown electronic components. Therefore, I learned to find the right SPECS, recreate schematic circuits and combine these circuits for a combination of functions. I learned this is especially useful in designing your own specific interactive system, especially

relevant for the 'special needs' target group. Furthermore, I have grown in my soldering skills, at home with self-bought soldering tools, without the help of d.search lab experts, which has increased my speed and precision enabling me to faster prototype interactive systems as UX designer. Another important insight to take with me is regards planning and flexibility. I learned to be proactive in the prototyping process, deal with unexpected breakdowns in program, circuit and sensor wiring which in the end gives me lots of satisfaction. Finally, I got the insight to start the prototyping process with calculations on the combined circuit of the entire interactive system to know on beforehand if it is technically feasible. However, since I experienced lots of difficulties with making the combined circuit work I found out how to break down the circuit, create an overview of the possible problems and learned to communicate with technical experts of d.search to solve them, or create back-up plans for design research with a not fully functional prototype.

Moreover, I wanted to enhance my practical physical prototyping skills with limited resources and tools due to COVID-19. I mainly learned about planning the physical prototyping process (prioritizing prototype elements in the 'making' process), efficient materials use and creating elements of the prototype with limited prototyping tools. Regarding the process planning I learned to think practical, make schematic drawings of the prototype layers, define what parts have priority when combining its layers and consider electronic circuiting issues when implementing in the prototype to adapt the circuiting. E.g, in my prototype I learned it was more efficient to first glue the LEDs to the prototype casing and solder them afterwards. Next to that, regarding efficient material use and prototyping tools, I learned to ask experienced designers and practical thinkers in my network for help. They gave me insights in which prototyping tools work best for what materials and how to deal with traditional prototyping tools as a Dremel or metal files. Furthermore, I learned to make technical drawings for paper molds to easily create the right shapes for prototype elements, such as the drum touch pads. These practicalities gave me lots of insights in how to efficiently use and select materials for rapid prototyping, to best study user experiences. Moreover, communicating my design and prototyping plans with these experts improved my presentation and communication skills tremendously, enhancing my professionalism.

Regarding User & Society and Design Research Processes, I have enriched my methodological approaches, improving online user evaluation skills, visual communication and presentation skills. Due to the Corona crisis and extra vulnerability of my target group I learned to involve experts in the design research process, through expert interviews, both in a design research inspirational manner and in an evaluative manner. This gave me the insight that when investigating specific target groups or design potentials in this context, involving experts can suffice as well. Furthermore, I learned that through 'accountability' in the design research process, arguing for all design research choices with regards to the target group, gives huge amounts of insights to reflect on as designer for special need groups and discuss in the paper. Moreover, I got acquainted with new and online evaluation methods as focus group sessions. I learned to prepare for focus groups; make existing methodological handouts suitable for my project; improved planning, organization by recruiting participants, ethical considerations (ERB form writing) and organizing and moderating the sessions to get targeted results. Next to that, I improved my visual communication skills by making 'video probes' for the focus groups to support me and the

participants in discussing anxiety experiences (scenario video) and design research potential (design and wrap-up video). This, by improving my Adobe Illustrator skills, creating clear and appealing visual screens for all videos; improving my photoshop skills for pictures in the design video; and video editing skills, including sound editing, to create all video probes.

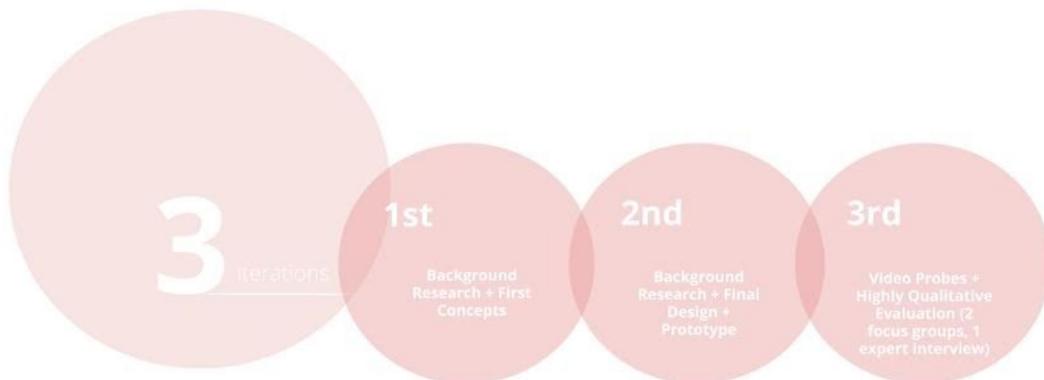
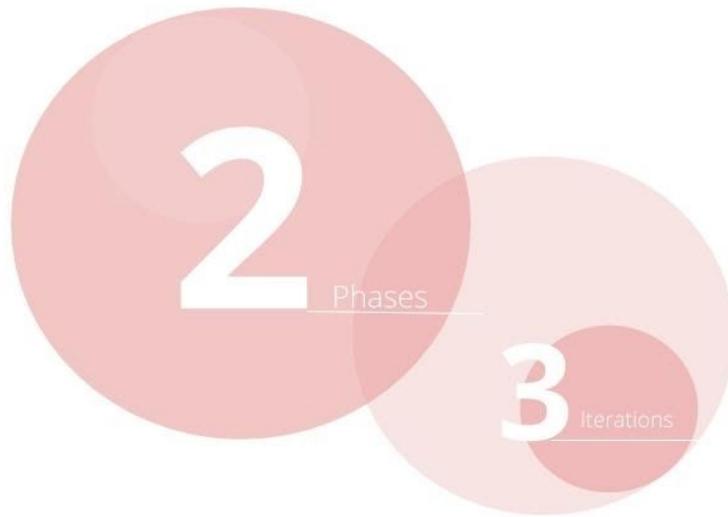
Because of changing to focus groups instead of controlled experiments, I unexpectedly learned to deal with a less convincing data set, biased by the fact the participants were not actually able to play/experience the drum. Therefore, I got new insights in how to combine quantitative self-reported data about anxiety levels (from the STAI) with qualitative discussion results to still answer the research question and conclude upon the 'potential' design effects instead of on the actual. In this way, I learned to make sense of a bunch of data (2 focus groups, 1 expert interview, 7 filled-in questionnaires), combining the thematically analyzed qualitative results with outliers in the quantitative STAI dataset to build up a narrative to conclude upon the research question. This analysis process really got me excited to improve my quantitative and statistical analysis skills in my second year master.

Due to working online I have made great professional skills development, especially in visual communication, presenting, planning & organization, as already mentioned before. I also improved my reflection skills by reflecting and reporting individually and collaboratively on all insights about the target group, context, design qualities, online evaluation methods, prototyping and approaches taken in Microsoft PowerPoint documents. Next to that, through organizing and attending weekly peer meetings, stand-up sessions and coach meetings, I had the chance to get feedback on my project for reflection. Finally, re-writing my PDP goals, identity and vision helped me reflect on the consequences of COVID-19 on me as design researcher.

Working on this project made me discover opportunities for programming as an evaluative method for UX in design research, supporting quantitative 'behavioral' measurements. Furthermore, the online education and COVID-19 situation, made me rethink my user-centered approaches, realizing the strength of expert involvement, especially in the field of clinical psychology, and online evaluation methods. For my career direction this implicates that these insights have opened up space in experience design for special need groups for online multi-stakeholder involvement, immersing in psychological knowledge and expertise around the target group and behavioral analysis through quantitative design measurements.

## Appendix B: Process Visualization

### *Process Phases and Iterations*

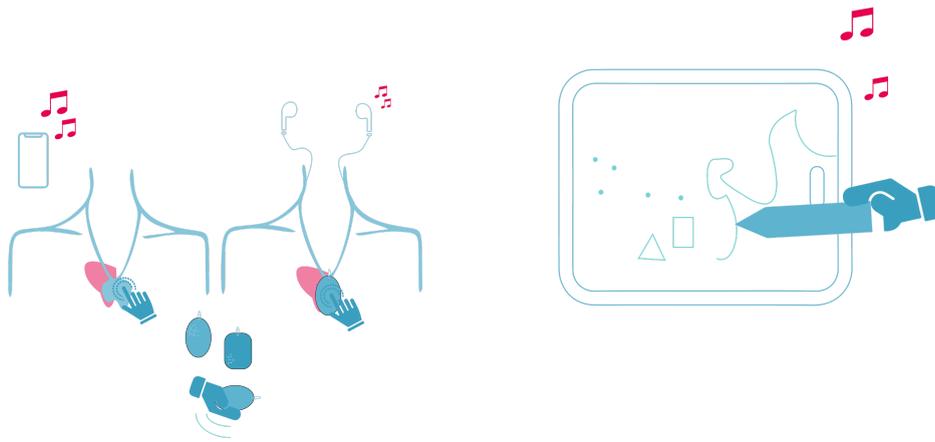
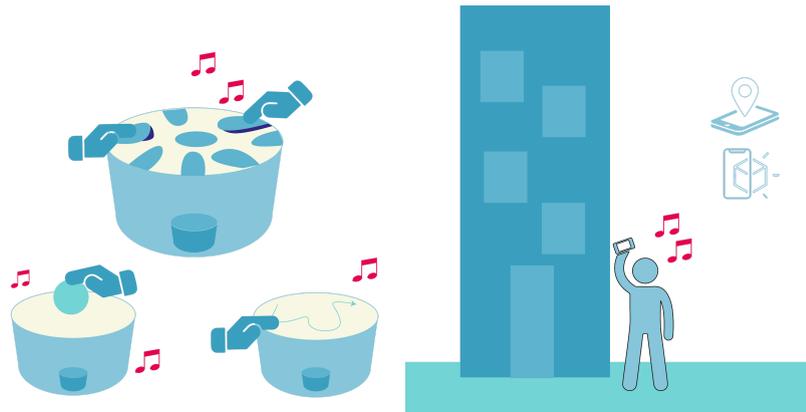


## Prototyping Process



## Appendix C: Extra Visuals

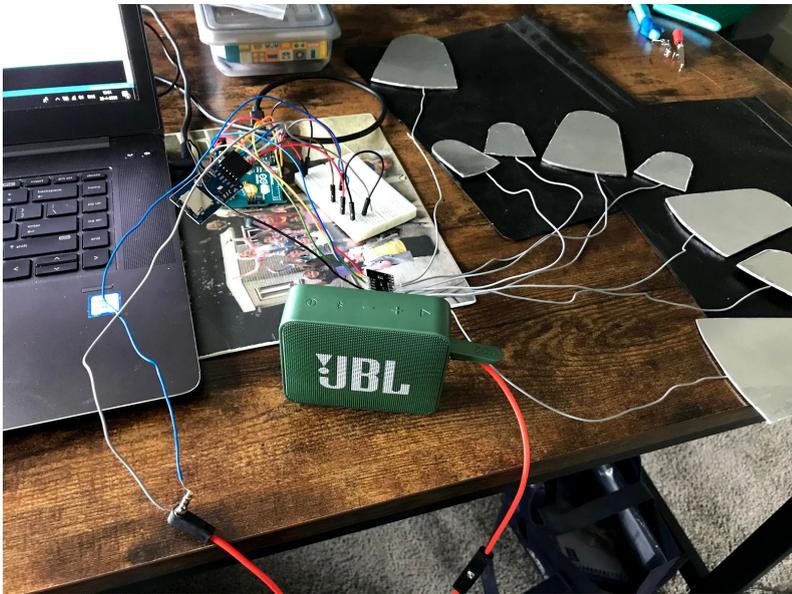
*First four design concepts*



- 1) Multi Drum (left upper), 2) Discovery (right upper), 3) Manipulatable Jewellery (right lower), 4) Draw Thoughts (right lower)

*Final three design concepts*



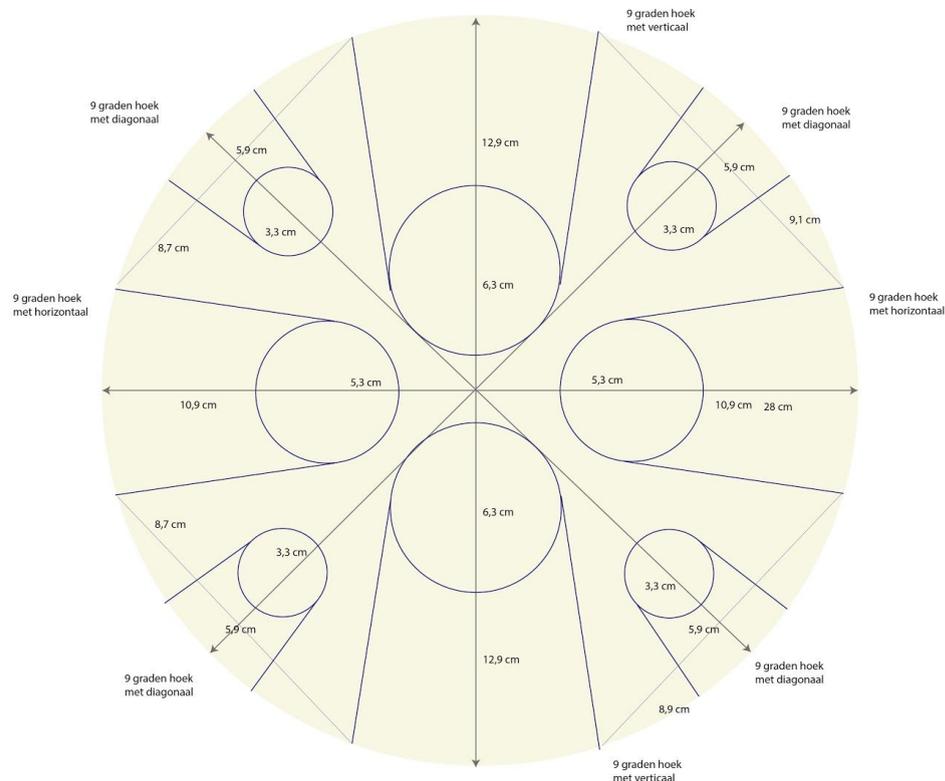




## Appendix D: Technicalities Prototype

### *Technical drawings for the shape of the metal tongues*

These were made to use as paper molds to paste on top of the aluminum before sawing and polishing the aluminum drum pads.



### *Arduino programming codes*

1. *Combined touch and music code (that already includes written feedback via the serial monitor for including the light function)*

This was the combined program for musical feedback based on touch input that measures the touch frequencies and turns on musical samples based on touch frequency conditions. Moreover, based on touch frequency conditions, this code already shows via the serial monitor, what the light function has to be. So in other words, this was the final program before problems arose when also integrating the three LED strips in the electronic circuit. Then it was discovered, even all separate functions did not want to work anymore, due to problems with the current.

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\*/

```
// captouch set-up
```

```
#include "mpr121.h"
```

```
#include <Wire.h>
```

```
int irqpin = 2; // Digital 2
```

```
boolean touchStates[12]; //to keep track of the previous touch states
```

```
//declaration and initialisation of the measuring period (sampling period)
```

```
unsigned long prevTime; // value keeping track of previous time of measurement (start)
```

```
unsigned long currentTime; // value keeping track of the current time of measurement
```

```
unsigned long measurePeriod = 10000; // measuring period
```

```

// declaration of the touchcounter values of all different tongues

int touchcounters[7]; // to keep track of the different touch counters, set in set-up for
all to 0!

// declaration of the previous touchcounter values of all different tongues

int prevtouchcounters[7]; // to keep track of the different previous touch counters, set
in set-up for all to 0!

// declaration of the total touchcounter values of all different tongues

int totaltouchcounters[7]; // to keep track of the different total touch counters, set in
set-up for all to 0!

// declaration of the previous total touchcounter values of all different tongues

int ptotaltouchcounters[7]; // to keep track of the different previous total touch
counters, set in set-up for all to 0!

//music set-up

#include <SD.h> //include SD module library

#include <TMRpcm.h> //include speaker control library

#define SD_ChipSelectPin 4 //define CS pin

/*#define buffSize 128 //must be an even number

#define SD_FULLSPEED

#define HANDLE_TAGS

//#define DISABLE_SPEAKER2

//#define USE_TIMER2

#define debug

#define ENABLE_MULTI */

TMRpcm tmrpcm; //create an object for speaker library

void setup(){

    pinMode(irqpin, INPUT);

    digitalWrite(irqpin, HIGH); //enable pullup resistor

```

```

Serial.begin(9600);

Wire.begin();

mpr121_setup();

for (int a=0; a<7; a++) {
    touchcounters[a] = 0;
}

for (int b=0; b<7; b++) {
    prevtouchcounters[b] = 0;
}

for(int c=0; c<7; c++) {
    totaltouchcounters[c] = 0;
}

for(int d=0; d<7; d++) {
    ptotaltouchcounters[d] = 0;
}

tmrpcm.speakerPin = 9;           //define speaker pin. Library uses pin 9

if (!SD.begin(SD_ChipSelectPin)) { //see if the card is present and can be
initialized

    return;                       //don't do anything more if not

}

tmrpcm.setVolume(1);             //0 to 7. Set volume level

tmrpcm.quality(1);

prevTime=millis();

}

void loop(){

    readTouchInputs();

```

```

if(!tmrpcm.isPlaying()) {

    digitalWrite(tmrpcm.speakerPin, LOW);

}

}

void readTouchInputs(){

    currentTime=millis();

    if(!checkInterrupt()){

        //read the touch state from the MPR121

        Wire.requestFrom(0x5A,2);

        byte LSB = Wire.read();

        byte MSB = Wire.read();

        uint16_t touched = ((MSB << 8) | LSB); //16bits that make up the touch states

        if(currentTime-prevTime > measurePeriod) { // if measuring time is over then, set
previous time to current time and all counters to 0, all prev counters to last touch
counters

            prevTime = currentTime;

            // light level if-statements after the measuring period is over, decide what light level
of each tongue does

            // check for all tongues, the light if-statements

            // check for all tongues, the volume conditions (if touchcount belongs to most often
and touched more, volume ++, if touchcount belongs to most offer but touched less,
volume --, if not most often but was, volume --)

            for(int a=0; a<7; a++) {

                if(touchcounters[a] >= 8 && touchcounters[a] < 11) {

                    switch(a) {

                        case 0:

                            if (touchcounters[a] < prevtouchcounters[0]) {

                                Serial.println("lightlevel the same tongue"); // light level actions

```

```
Serial.println("volume 0 -1"); // include volume always needs to be higher than  
0 (if statement) + include if volume was highest of all, not anymore, G-1/4 volume
```

```
Serial.print(a);
```

```
}
```

```
else {
```

```
Serial.println("lightlevel + 1 tongue");
```

```
Serial.println("volume 0 +1"); // include if volume is highest of all tongues, G  
+1/4 volume
```

```
Serial.print(a);
```

```
}
```

```
break;
```

```
case 1:
```

```
if (touchcounters[a] < prevtouchcounters[1]) {
```

```
Serial.println("lightlevel the same tongue");
```

```
Serial.println("volume 1 -1"); // include volume always needs to be higher than  
0 (if statement) + include if volume was highest of all, not anymore, G-1/4 volume
```

```
Serial.print(a);
```

```
}
```

```
else {
```

```
Serial.println("lightlevel + 1 tongue");
```

```
Serial.println("volume 1 +1"); // include if volume is highest of all tongues, G  
+1/4 volume
```

```
Serial.print(a);
```

```
}
```

```
break;
```

```
case 2:
```

```
if (touchcounters[a] < prevtouchcounters[2]) {
```

```

    Serial.println("lightlevel the same tongue");

    Serial.println("volume 2 -1"); // include volume always needs to be higher than
0 (if statement) + include if volume was highest of all, not anymore, G-1/4 volume

    Serial.print(a);

}

else {

    Serial.println("lightlevel + 1 tongue");

    Serial.println("volume 2 +1"); // include if volume is highest of all tongues, G
+1/4 volume

    Serial.print(a);

}

break;

case 3:

if (touchcounters[a] < prevtouchcounters[3]) {

    Serial.println("lightlevel the same tongue");

    Serial.println("volume 3 -1"); // include volume always needs to be higher than
0 (if statement) + include if volume was highest of all, not anymore, G-1/4 volume

    Serial.print(a);

}

else {

    Serial.println("lightlevel + 1 tongue");

    Serial.println("volume 3 +1"); // include if volume is highest of all tongues, G
+1/4 volume

    Serial.print(a);

}

break;

case 4:

```

```

    if (touchcounters[a] < prevtouchcounters[4]) {

        Serial.println("lightlevel the same tongue");

        Serial.println("volume 4 -1"); // include volume always needs to be higher than
0 (if statement) + include if volume was highest of all, not anymore, G-1/4 volume

        Serial.print(a);

    }

    else {

        Serial.println("lightlevel + 1 tongue");

        Serial.println("volume 4 +1"); // include if volume is highest of all tongues, G
+1/4 volume

        Serial.print(a);

    }

    break;

    case 5:

    if (touchcounters[a] < prevtouchcounters[5]) {

        Serial.println("lightlevel the same tongue");

        Serial.println("volume 5 -1"); // include volume always needs to be higher than
0 (if statement) + include if volume was highest of all, not anymore, G-1/4 volume

        Serial.print(a);

    }

    else {

        Serial.println("lightlevel + 1 tongue");

        Serial.println("volume 5 +1"); // include if volume is highest of all tongues, G
+1/4 volume

        Serial.print(a);

    }

    break;

```

```

case 6:

    if (touchcounters[a] < prevtouchcounters[6]) {

        Serial.println("lightlevel the same tongue");

        Serial.println("volume 6 -1"); // include volume always needs to be higher than
0 (if statement) + include if volume was highest of all, not anymore, G-1/4 volume

        Serial.print(a);

    }

    else {

        Serial.println("lightlevel + 1 tongue");

        Serial.println("volume 6 +1"); // include if volume is highest of all tongues, G
+1/4 volume

        Serial.print(a);

    }

    break;

case 7:

    if (touchcounters[a] < prevtouchcounters[7]) {

        Serial.println("lightlevel the same tongue");

        Serial.println("volume 7 -1"); // include volume always needs to be higher than
0 (if statement) + include if volume was highest of all, not anymore, G-1/4 volume

        Serial.print(a);

    }

    else {

        Serial.println("lightlevel + 1 tongue");

        Serial.println("volume 7 +1"); // include if volume is highest of all tongues, G
+1/4 volume

        Serial.print(a);

    }

```

```

        break;
    }
}

else if (touchcounters[a] >= 11 && touchcounters[a] < 15) {

    switch(a) {

        case 0:

            if (touchcounters[a] < prevtouchcounters[0]) {

                Serial.println("lightlevel +1 tongue");

                Serial.println("volume 0 -1"); // include volume always needs to be higher than
0 (if statement) + include if volume was highest of all, not anymore, G-1/4 volume

                Serial.print(a);

            }

            else {

                Serial.println("lightlevel + 2 tongue");

                Serial.println("volume 0 +1"); // include if volume is highest of all tongues, G
+1/4 volume

                Serial.print(a);

            }

            break;

        case 1:

            if (touchcounters[a] < prevtouchcounters[1]) {

                Serial.println("lightlevel +1 tongue");

                Serial.println("volume 1 -1"); // include volume always needs to be higher than
0 (if statement) + include if volume was highest of all, not anymore, G-1/4 volume

                Serial.print(a);

            }

            else {

```

```

Serial.println("lightlevel + 2 tongue");

Serial.println("volume 1 +1"); // include if volume is highest of all tongues, G
+1/4 volume

Serial.print(a);
}

break;

case 2:

if (touchcounters[a] < prevtouchcounters[2]) {

Serial.println("lightlevel +1 tongue");

Serial.println("volume 2 -1"); // include volume always needs to be higher than
0 (if statement) + include if volume was highest of all, not anymore, G-1/4 volume

Serial.print(a);
}

else {

Serial.println("lightlevel + 2 tongue");

Serial.println("volume 2 +1"); // include if volume is highest of all tongues, G
+1/4 volume

Serial.print(a);
}

break;

case 3:

if (touchcounters[a] < prevtouchcounters[3]) {

Serial.println("lightlevel +1 tongue");

Serial.println("volume 3 -1"); // include volume always needs to be higher than
0 (if statement) + include if volume was highest of all, not anymore, G-1/4 volume

Serial.print(a);
}

```

```

else {

    Serial.println("lightlevel + 2 tongue");

    Serial.println("volume 3 +1"); // include if volume is highest of all tongues, G
+1/4 volume

    Serial.print(a);

}

break;

case 4:

if (touchcounters[a] < prevtouchcounters[4]) {

    Serial.println("lightlevel +1 tongue");

    Serial.println("volume 4 -1"); // include volume always needs to be higher than
0 (if statement) + include if volume was highest of all, not anymore, G-1/4 volume

    Serial.print(a);

}

else {

    Serial.println("lightlevel + 2 tongue");

    Serial.println("volume 4 +1"); // include if volume is highest of all tongues, G
+1/4 volume

    Serial.print(a);

}

break;

case 5:

if (touchcounters[a] < prevtouchcounters[5]) {

    Serial.println("lightlevel +1 tongue");

    Serial.println("volume 5 -1"); // include volume always needs to be higher than
0 (if statement) + include if volume was highest of all, not anymore, G-1/4 volume

    Serial.print(a);

```

```

}

else {

    Serial.println("lightlevel + 2 tongue");

    Serial.println("volume 5 +1"); // include if volume is highest of all tongues, G
+1/4 volume

    Serial.print(a);

}

break;

case 6:

    if (touchcounters[a] < prevtouchcounters[6]) {

        Serial.println("lightlevel +1 tongue");

        Serial.println("volume 6 -1"); // include volume always needs to be higher than
0 (if statement) + include if volume was highest of all, not anymore, G-1/4 volume

        Serial.print(a);

    }

    else {

        Serial.println("lightlevel + 2 tongue");

        Serial.println("volume 6 +1"); // include if volume is highest of all tongues, G
+1/4 volume

        Serial.print(a);

    }

    break;

case 7:

    if (touchcounters[a] < prevtouchcounters[7]) {

        Serial.println("lightlevel +1 tongue");

        Serial.println("volume 7 -1"); // include volume always needs to be higher than
0 (if statement) + include if volume was highest of all, not anymore, G-1/4 volume

```

```

    Serial.print(a);
}
else {
    Serial.println("lightlevel + 2 tongue");

    Serial.println("volume 7 +1"); // include if volume is highest of all tongues, G
+1/4 volume

    Serial.print(a);
}
break;
}
}
else if (touchcounters[a] > 15) {
    switch(a) {
        case 0:
            if (touchcounters[a] < prevtouchcounters[0]) {
                Serial.println("lightlevel +2 tongue");

                Serial.println("volume 0 -1"); // include volume always needs to be higher than
0 (if statement) + include if volume was highest of all, not anymore, G-1/4 volume

                Serial.print(a);
            }
        else {
            Serial.println("lightlevel + 3 tongue");

            Serial.println("volume 0 +1"); // include if volume is highest of all tongues, G
+1/4 volume

            Serial.print(a);
        }
    }
    break;
}

```

case 1:

```
if (touchcounters[a] < prevtouchcounters[1]) {
```

```
    Serial.println("lightlevel +2 tongue");
```

```
    Serial.println("volume 1 -1"); // include volume always needs to be higher than  
0 (if statement) + include if volume was highest of all, not anymore, G-1/4 volume
```

```
    Serial.print(a);
```

```
}
```

```
else {
```

```
    Serial.println("lightlevel + 3 tongue");
```

```
    Serial.println("volume 1 +1"); // include if volume is highest of all tongues, G  
+1/4 volume
```

```
    Serial.print(a);
```

```
}
```

```
break;
```

case 2:

```
if (touchcounters[a] < prevtouchcounters[2]) {
```

```
    Serial.println("lightlevel +2 tongue");
```

```
    Serial.println("volume 2 -1"); // include volume always needs to be higher than  
0 (if statement) + include if volume was highest of all, not anymore, G-1/4 volume
```

```
    Serial.print(a);
```

```
}
```

```
else {
```

```
    Serial.println("lightlevel + 3 tongue");
```

```
    Serial.println("volume 2 +1"); // include if volume is highest of all tongues, G  
+1/4 volume
```

```
    Serial.print(a);
```

```
}
```

```

break;

case 3:

if (touchcounters[a] < prevtouchcounters[3]) {

    Serial.println("lightlevel +2 tongue");

    Serial.println("volume 3 -1"); // include volume always needs to be higher than
0 (if statement) + include if volume was highest of all, not anymore, G-1/4 volume

    Serial.print(a);

}

else {

    Serial.println("lightlevel + 3 tongue");

    Serial.println("volume 3 +1"); // include if volume is highest of all tongues, G
+1/4 volume

    Serial.print(a);

}

break;

case 4:

if (touchcounters[a] < prevtouchcounters[4]) {

    Serial.println("lightlevel +2 tongue");

    Serial.println("volume 4 -1"); // include volume always needs to be higher than
0 (if statement) + include if volume was highest of all, not anymore, G-1/4 volume

    Serial.print(a);

}

else {

    Serial.println("lightlevel +3 tongue");

    Serial.println("volume 4 +1"); // include if volume is highest of all tongues, G
+1/4 volume

    Serial.print(a);

```

```

}

break;

case 5:

if (touchcounters[a] < prevtouchcounters[5]) {

    Serial.println("lightlevel +2 tongue");

    Serial.println("volume 5 -1"); // include volume always needs to be higher than
0 (if statement) + include if volume was highest of all, not anymore, G-1/4 volume

    Serial.print(a);

}

else {

    Serial.println("lightlevel +3 tongue");

    Serial.println("volume 5 +1"); // include if volume is highest of all tongues, G
+1/4 volume

    Serial.print(a);

}

break;

case 6:

if (touchcounters[a] < prevtouchcounters[6]) {

    Serial.println("lightlevel +2 tongue");

    Serial.println("volume 6 -1"); // include volume always needs to be higher than
0 (if statement) + include if volume was highest of all, not anymore, G-1/4 volume

    Serial.print(a);

}

else {

    Serial.println("lightlevel +3 tongue");

    Serial.println("volume 6 +1"); // include if volume is highest of all tongues, G
+1/4 volume

```

```

    Serial.print(a);
}
break;
case 7:
    if (touchcounters[a] < prevtouchcounters[7]) {
        Serial.println("lightlevel +2 tongue");

        Serial.println("volume 7 -1"); // include volume always needs to be higher than
0 (if statement) + include if volume was highest of all, not anymore, G-1/4 volume

        Serial.print(a);
    }
    else {
        Serial.println("lightlevel +3 tongue");

        Serial.println("volume 7 +1"); // include if volume is highest of all tongues, G
+1/4 volume

        Serial.print(a);
    }
    break;
}
}
else if (touchcounters[a] < 8) {
    switch(a) {
        case 0:
            if (prevtouchcounters[0] >= 8) {
                Serial.println("lightlevel -1 tongue");

                Serial.println("volume 0 -1"); // include volume always needs to be higher than
0 (if statement) + include if volume was highest of all, not anymore, G-1/4 volume

                Serial.print(a);
            }
        }
    }
}
}

```

```

    // if lightlevel G_low < 0 then lightlevel G_low is 0
}
break;

case 1:

if (prevtouchcounters[1] >= 8) {

    Serial.println("lightlevel -1 tongue");

    Serial.println("volume 1 -1"); // include volume always needs to be higher than
0 (if statement) + include if volume was highest of all, not anymore, G-1/4 volume

    Serial.print(a);

    // if lightlevel G_low < 0 then lightlevel G_low is 0
}

break;

case 2:

if (prevtouchcounters[2] >=8) {

    Serial.println("lightlevel -1 tongue");

    Serial.println("volume 2 -1"); // include volume always needs to be higher than
0 (if statement) + include if volume was highest of all, not anymore, G-1/4 volume

    Serial.print(a);

    // if lightlevel G_low < 0 then lightlevel G_low is 0
}

break;

case 3:

if (prevtouchcounters[3] >=8) {

    Serial.println("lightlevel -1 tongue");

    Serial.println("volume 3 -1"); // include volume always needs to be higher than
0 (if statement) + include if volume was highest of all, not anymore, G-1/4 volume

    Serial.print(a);

```

```

    // if lightlevel G_low < 0 then lightlevel G_low is 0
}

break;

case 4:

    if (prevtouchcounters[4] >=8) {

        Serial.println("lightlevel -1 tongue");

        Serial.println("volume 4 -1"); // include volume always needs to be higher than
0 (if statement) + include if volume was highest of all, not anymore, G-1/4 volume

        Serial.print(a);

        // if lightlevel G_low < 0 then lightlevel G_low is 0
    }

    break;

case 5:

    if (prevtouchcounters[5] >=8) {

        Serial.println("lightlevel -1 tongue");

        Serial.println("volume 5 -1"); // include volume always needs to be higher than
0 (if statement) + include if volume was highest of all, not anymore, G-1/4 volume

        Serial.print(a);

        // if lightlevel G_low < 0 then lightlevel G_low is 0
    }

    break;

case 6:

    if (prevtouchcounters[6] >=8) {

        Serial.println("lightlevel -1 tongue");

        Serial.println("volume 6 -1"); // include volume always needs to be higher than
0 (if statement) + include if volume was highest of all, not anymore, G-1/4 volume

        Serial.print(a);

```

```

    // if lightlevel G_low < 0 then lightlevel G_low is 0
}
break;

case 7:

    if (prevtouchcounters[7] >=8) {

        Serial.println("lightlevel -1 tongue");

        Serial.println("volume 7 -1"); // include volume always needs to be higher than
0 (if statement) + include if volume was highest of all, not anymore, G-1/4 volume

        Serial.print(a);

        // if lightlevel G_low < 0 then lightlevel G_low is 0

    }

    break;

}

}

}

prevtouchcounters[0] = touchcounters[0];
prevtouchcounters[7] = touchcounters[7];
prevtouchcounters[1] = touchcounters[1];
prevtouchcounters[2] = touchcounters[2];
prevtouchcounters[4] = touchcounters[4]; //Dright
prevtouchcounters[3] = touchcounters[3]; //Dleft
prevtouchcounters[5] = touchcounters[5];
prevtouchcounters[6] = touchcounters[6];

for(int a=0; a<7; a++) {

    touchcounters[a] = 0;

}

```

```
//touchcounter_Glow = 0;

//touchcounter_Ghigh = 0;

//touchcounter_A = 0;

//touchcounter_C = 0;

//touchcounter_Dright = 0;

//touchcounter_Dleft = 0;

//touchcounter_E = 0;

//touchcounter_B = 0;

}

else{

for (int i=0; i < 12; i++){ // Check what electrodes were pressed

    if(touched & (1<<i)){

        if(touchStates[i] == 0){

            //pin i was just touched

            Serial.print("pin ");

            Serial.print(i);

            Serial.println(" was just touched");

            switch(i) {

                case 0:

                    //Serial.println("lower G music");

                    tmrpcm.play("G4long.wav");

                    touchcounters[0] ++;

                    //Serial.println(prevtouchcounters[0]);

                    //Serial.println(touchcounters[0]);

                    break;
```

```
case 1:

//Serial.println("A");

tmrpcm.play("A.wav");

touchcounters[1] ++;

//Serial.println(prevtouchcounters[1]);

//Serial.println(touchcounters[1]);

break;

case 2:

// Serial.println("C");

tmrpcm.play("C.wav");

touchcounters[2] ++;

//Serial.println(prevtouchcounters[2]);

//Serial.println(touchcounters[2]);

break;

case 3:

// Serial.println("D");

tmrpcm.play("D.wav");

touchcounters[3] ++;

// Serial.println(prevtouchcounters[3]);

//Serial.println(touchcounters[3]);

break;

case 4:

//Serial.println("D");

tmrpcm.play("D.wav");

touchcounters[4] ++;
```

```
//Serial.println(prevtouchcounters[4]);  
  
// Serial.println(touchcounters[4]);  
  
break;  
  
case 5:  
  
// Serial.println("E");  
  
tmrpcm.play("E.wav");  
  
touchcounters[5] ++;  
  
//Serial.println(prevtouchcounters[5]);  
  
//Serial.println(touchcounters[5]);  
  
break;  
  
case 6:  
  
// Serial.println("B");  
  
tmrpcm.play("C.wav");  
  
touchcounters[6] ++;  
  
//Serial.println(prevtouchcounters[6]);  
  
//Serial.println(touchcounters[6]);  
  
break;  
  
case 7:  
  
//Serial.println("higherG");  
  
tmrpcm.play("G4long.wav");  
  
touchcounters[7] ++;  
  
// Serial.println(prevtouchcounters[7]);  
  
//Serial.println(touchcounters[7]);  
  
break;  
  
}
```

```

    }else if(touchStates[i] == 1){
        //pin i is still being touched
    }
    touchStates[i] = 1;
}
else{
    if(touchStates[i] == 1){
        Serial.print("pin ");
        Serial.print(i);
        Serial.println(" is no longer being touched");
        //pin i is no longer being touched
    }
    touchStates[i] = 0;
}
}
}

// print the values of the previous touchcounters and current touchcounters in the
serial monitor

/* for(int b=0; b<7; b++) {
    Serial.println(prevtouchcounters[b]);
}
for(int a=0; a<7; a++) {
    Serial.println(touchcounters[a]);
}*/
}
}

```

```
void mpr121_setup(void){  
  
    set_register(0x5A, ELE_CFG, 0x00);  
  
    // Section A - Controls filtering when data is > baseline.  
  
    set_register(0x5A, MHD_R, 0x01);  
    set_register(0x5A, NHD_R, 0x01);  
    set_register(0x5A, NCL_R, 0x00);  
    set_register(0x5A, FDL_R, 0x00);  
  
    // Section B - Controls filtering when data is < baseline.  
  
    set_register(0x5A, MHD_F, 0x01);  
    set_register(0x5A, NHD_F, 0x01);  
    set_register(0x5A, NCL_F, 0xFF);  
    set_register(0x5A, FDL_F, 0x02);  
  
    // Section C - Sets touch and release thresholds for each electrode  
  
    set_register(0x5A, ELE0_T, TOU_THRESH);  
    set_register(0x5A, ELE0_R, REL_THRESH);  
  
    set_register(0x5A, ELE1_T, TOU_THRESH);  
    set_register(0x5A, ELE1_R, REL_THRESH);  
  
    set_register(0x5A, ELE2_T, TOU_THRESH);  
    set_register(0x5A, ELE2_R, REL_THRESH);  
  
    set_register(0x5A, ELE3_T, TOU_THRESH);  
    set_register(0x5A, ELE3_R, REL_THRESH);  
}
```

```
set_register(0x5A, ELE4_T, TOU_THRESH);
```

```
set_register(0x5A, ELE4_R, REL_THRESH);
```

```
set_register(0x5A, ELE5_T, TOU_THRESH);
```

```
set_register(0x5A, ELE5_R, REL_THRESH);
```

```
set_register(0x5A, ELE6_T, TOU_THRESH);
```

```
set_register(0x5A, ELE6_R, REL_THRESH);
```

```
set_register(0x5A, ELE7_T, TOU_THRESH);
```

```
set_register(0x5A, ELE7_R, REL_THRESH);
```

```
set_register(0x5A, ELE8_T, TOU_THRESH);
```

```
set_register(0x5A, ELE8_R, REL_THRESH);
```

```
set_register(0x5A, ELE9_T, TOU_THRESH);
```

```
set_register(0x5A, ELE9_R, REL_THRESH);
```

```
set_register(0x5A, ELE10_T, TOU_THRESH);
```

```
set_register(0x5A, ELE10_R, REL_THRESH);
```

```
set_register(0x5A, ELE11_T, TOU_THRESH);
```

```
set_register(0x5A, ELE11_R, REL_THRESH);
```

```
// Section D
```

```
// Set the Filter Configuration
```

```

// Set ESI2

set_register(0x5A, FIL_CFG, 0x04);

// Section E

// Electrode Configuration

// Set ELE_CFG to 0x00 to return to standby mode

set_register(0x5A, ELE_CFG, 0x0C); // Enables all 12 Electrodes

// Section F

// Enable Auto Config and auto Reconfig

/*set_register(0x5A, ATO_CFG0, 0x0B);

set_register(0x5A, ATO_CFGU, 0xC9); // USL = (Vdd-0.7)/vdd*256 = 0xC9 @3.3V
set_register(0x5A, ATO_CFGL, 0x82); // LSL = 0.65*USL = 0x82 @3.3V

set_register(0x5A, ATO_CFGT, 0xB5);*/ // Target = 0.9*USL = 0xB5 @3.3V

set_register(0x5A, ELE_CFG, 0x0C);

}

boolean checkInterrupt(void){

return digitalRead(irqpin);

}

void set_register(int address, unsigned char r, unsigned char v){

Wire.beginTransmission(address);

Wire.write(r);

Wire.write(v);

Wire.endTransmission();

}

```

## 2. Example codes of the light color fading interaction

These are codes that are used in the 'design video' probe, to mimic the light color fading based on touch input, for various types of interactions with the drum. I will give the two most interesting examples, showing how the light colors fade to recreate the feedback mechanism when play intensity is increased on the "most touched pads" and when play intensity is varied including others then the "most touched pads".

### 2.1 Play intensity is increased on the "most touched pads"

// ArrayOfLedArrays - see

<https://github.com/FastLED/FastLED/wiki/Multiple-Controller-Examples> for more info on

// using multiple controllers. In this example, we're going to set up four NEOPIXEL strips on three

// different pins, each strip getting its own CRGB array to be played with, only this time they're going

// to be all parts of an array of arrays.

// video light code, only G's go on after 2 seconds

```
#include "FastLED.h"
```

```
#define NUM_STRIPS 3
```

```
#define NUM_LEDS_PER_STRIP 8
```

```
//#define NUM_LEDS_OUTSIDE_STRIP 6
```

```
//#define NUM_LEDS_G_STRIP 8
```

```
#define LED_PIN1 10
```

```
#define LED_PIN2 8
```

```
#define LED_PIN3 6
```

```
#define BRIGHTNESS 40 // starting brightness is 40
```

```
#define LED_TYPE WS2812B // led type is WS2812B
```

```
#define COLOR_ORDER GRB // color order RGB
```

```
CRGB leds[NUM_STRIPS][NUM_LEDS_PER_STRIP]; // array to turn on different LED areas in the various strips
```

```

CHSV color[7];    // declare array to turn on LEDs in one of the 7 colors 0 until 6,
including black (lights out)

int cCleft = 0;    // variable for the color of the LEDs

int cDleft = 0;

int cEleft = 0;

int cGup = 0;

int cGdown = 0;

int cAright = 0;

int cDright = 0;

int cCright = 0;

// fading variables

int FastLED_fade_counter = 254; // variable to maximize brightness to 254

//int state_fade = 1;    // variable to check in which fading state LED is

//int previous_state_fade = 0; // variable to check previous fading state

int val = 0;

void setup() {

  Serial.begin(9600);

  // just addLeds multiple times, once for each strip

  // tell FastLED there's 6 NEOPIXEL leds on pin 10

  FastLED.addLeds<NEOPIXEL, 10>(leds[0], NUM_LEDS_PER_STRIP);

  // tell FastLED there's 8 NEOPIXEL leds on pin 8

  FastLED.addLeds<NEOPIXEL, 8>(leds[1], NUM_LEDS_PER_STRIP);

  // tell FastLED there's 6 NEOPIXEL leds on pin 6

  FastLED.addLeds<NEOPIXEL, 6>(leds[2], NUM_LEDS_PER_STRIP);

  // set-up the color values in the color array

  color[0] = CHSV(0,0,0); // Black

```

```

color[1] = CHSV(240,8,98); // Lavender
//color[1] = CRGB(230,230,250); // Lavender
color[2] = CHSV(147, 8, 98); // Medium Purple
//color[2] = CRGB(147, 112, 219); // Medium Purple
color[3] = CHSV(138, 8, 98); // Blue Violet
//color[3] = CRGB(138, 43, 226); // Blue Violet
color[4] = CHSV(246, 8, 98); // Pinkish
//color[4] = CRGB(246, 70, 91); // Pinkish
color[5] = CHSV(244,8,98); // Redish
//color[5] = CRGB(244,41,65); // Redish
color[6] = CHSV(202,8,98); // Dark Red
//color[6] = CRGB(202,0,42); // Dark Red

// turn on G areas in color level 1 from beginning on, no matter what happens and
the rest in black (lights out)

for(int m = 0; m< NUM_LEDS_PER_STRIP; m++) {

  leds[1][m] = color[0];

  FastLED.show();

  leds[0][m] = color[0];

  FastLED.show();

  leds[2][m] = color[0];

  FastLED.show();

}

}

void loop() {

  // This outer loop will go over each strip, one at a time

  for(int l=0; l<2; l++) {

```

```

// turn on left C
leds[0][i] = color[0];
//FastLED.show();
}
for(int l=2; l<4; l++) {
// turn on left D
leds[0][l] = color[0];
//leds[0][l] = CHSV(0, cDright,98);
//FastLED.show();
}
for(int l=4; l<NUM_LEDS_PER_STRIP; l++) {
// turn on left E
leds[0][l] = color[1];
//leds[0][l].fadeToBlackBy(64);
//FastLED.show();
}
for(int j = 2; j < 6; j++) {
// turn on lower G
//leds[1][j] = CHSV(0,cGup,98);
leds[1][j] = CHSV(0,50,98);
//FastLED.show();
}
for(int j=0; j<2; j++) {
// turn on left part of upper G
leds[1][j] = CHSV(0,100,98);

```

```

    //FastLED.show();
}
for(int j=6; j<NUM_LEDS_PER_STRIP; j++) {
    // turn on second right part of upper G
    leds[1][j] = CHSV(0,100,98);
    //FastLED.show();
}
for(int k = cGdown; k< 2; k++) {
    // turn on right A
    leds[2][k] = CHSV(0,cAright,98);
    //leds[2][k] = color[0];
    //FastLED.show();
}
for(int k = 2; k<4; k++) {
    // turn on right D
    //leds[2][k] = color[4];
    leds[2][k] = CHSV(0, cDright,98);
    //FastLED.show();
}
for(int k = 4; k<NUM_LEDS_PER_STRIP; k++) {
    // turn on right C
    leds[2][k] = CHSV(0,cCright,98);
    //FastLED.show();
}
FastLED.show();

```

```

//cGdown +=20;

//cGup +=5;

//Serial.println(cGup);

cDright +=10;

cArightright +=15;

cCrightright +=15;

delay(1000);

}

```

2.2 *Play intensity is varied including others then the “most touched pads”.*

// ArrayOfLedArrays - see  
<https://github.com/FastLED/FastLED/wiki/Multiple-Controller-Examples> for more info  
on

// using multiple controllers. In this example, we're going to set up four NEOPIXEL  
strips on three

// different pins, each strip getting its own CRGB array to be played with, only this  
time they're going

// to be all parts of an array of arrays.

// video light code, only G's go on after 2 seconds

```
#include "FastLED.h"
```

```
#define NUM_STRIPS 3
```

```
#define NUM_LEDS_PER_STRIP 8
```

```
//#define NUM_LEDS_OUTSIDE_STRIP 6
```

```
//#define NUM_LEDS_G_STRIP 8
```

```
#define LED_PIN1 10
```

```
#define LED_PIN2 8
```

```
#define LED_PIN3 6
```

```
#define BRIGHTNESS 40 // starting brightness is 40
```

```

#define LED_TYPE    WS2812B // led type is WS2812B

#define COLOR_ORDER GRB // color order RGB

CRGB leds[NUM_STRIPS][NUM_LEDS_PER_STRIP]; // array to turn on different
LED areas in the various strips

CHSV color[7];    // declare array to turn on LEDs in one of the 7 colors 0 untill 6,
including black (lights out)

int cCleft = 0;    // variable for the color of the LEDs

int cDleft = 0;

int cEleft = 0;

int cGup = 0;

int cGdown = 0;

int cAright = 0;

int cDrightright = 0;

int cCrightright = 0;

// fading variables

int FastLED_fade_counter = 254; // variable to maximize brightness to 254

//int state_fade = 1;    // variable to check in which fading state LED is

//int previous_state_fade = 0; // variable to check previous fading state

int val = 0;

void setup() {

    Serial.begin(9600);

    // just addLeds multiple times, once for each strip

    // tell FastLED there's 6 NEOPIXEL leds on pin 10

    FastLED.addLeds<NEOPIXEL, 10>(leds[0], NUM_LEDS_PER_STRIP);

    // tell FastLED there's 8 NEOPIXEL leds on pin 8

    FastLED.addLeds<NEOPIXEL, 8>(leds[1], NUM_LEDS_PER_STRIP);

```

```

// tell FastLED there's 6 NEOPIXEL leds on pin 6

FastLED.addLeds<NEOPIXEL, 6>(leds[2], NUM_LEDS_PER_STRIP);

// set-up the color values in the color array

color[0] = CHSV(0,0,0); // Black

color[1] = CHSV(240,8,98); // Lavender

//color[1] = CRGB(230,230,250); // Lavender

color[2] = CHSV(147, 8, 98); // Medium Purple

//color[2] = CRGB(147, 112, 219); // Medium Purple

color[3] = CHSV(138, 8, 98); // Blue Violet

//color[3] = CRGB(138, 43, 226); // Blue Violet

color[4] = CHSV(246, 8, 98); // Pinkish

//color[4] = CRGB(246, 70, 91); // Pinkish

color[5] = CHSV(244,8,98); // Redish

//color[5] = CRGB(244,41,65); // Redish

color[6] = CHSV(202,8,98); // Dark Red

//color[6] = CRGB(202,0,42); // Dark Red

// turn on G areas in color level 1 from beginning on, no matter what happens and
the rest in black (lights out)

for(int m = 0; m< NUM_LEDS_PER_STRIP; m++) {

  leds[1][m] = color[0];

  FastLED.show();

  leds[0][m] = color[0];

  FastLED.show();

  leds[2][m] = color[0];

  FastLED.show();

}

```

```

}

void loop() {

  // This outer loop will go over each strip, one at a time

  for(int l=0; l<2; l++) {

    // turn on left C

    leds[0][l] = CHSV(0,cCleft,98);

    //FastLED.show();

  }

  for(int l=2; l<4; l++) {

    // turn on left D

    //leds[0][l] = color[0];

    leds[0][l] = CHSV(0, cDleft,98);

    //FastLED.show();

  }

  for(int l=4; l<NUM_LEDS_PER_STRIP; l++) {

    // turn on left E

    //leds[0][l] = color[1];

    leds[0][l] = CHSV(0,cEleft,98);

    //leds[0][1].fadeToBlackBy(64);

    //FastLED.show();

  }

  for(int j = 2; j< 6; j++) {

    // turn on lower G

    //leds[1][j] = CHSV(0,cGup,98);

    leds[1][j] = CHSV(0,50,98);
  }
}

```

```
//FastLED.show();  
}  
for(int j=0; j<2; j++) {  
    // turn on left part of upper G  
    leds[1][j] = CHSV(0,100,98);  
    //FastLED.show();  
}  
for(int j=6; j<NUM_LEDS_PER_STRIP; j++) {  
    // turn on second right part of upper G  
    leds[1][j] = CHSV(0,100,98);  
    //FastLED.show();  
}  
for(int k = cGdown; k< 2; k++) {  
    // turn on right A  
    leds[2][k] = CHSV(0,cArigh,98);  
    //leds[2][k] = color[0];  
    //FastLED.show();  
}  
for(int k = 2; k<4; k++) {  
    // turn on right D  
    //leds[2][k] = color[4];  
    leds[2][k] = CHSV(0, cDright,98);  
    //FastLED.show();  
}  
for(int k = 4; k<NUM_LEDS_PER_STRIP; k++) {
```

```
// turn on right C
leds[2][k] = CHSV(0,cCright,98);
}
FastLED.show();
//cGdown +=20;
//cGup +=5;
//Serial.println(cGup);
cDright +=10;
cAright +=15;
cCright +=15;
cDleft +=5;
cCleft +=3;
cEleft +=8;
delay(1000);
//Serial.println(FastLED_fade_counter);
}
```

## Appendix E: Consent Forms

This appendix includes the consent forms of the inspirational expert interviews, final focus groups and final expert interview.

*Inspirational expert interviews*

# Consent Form

**Title:** Anxiety and playful musical objects for relaxation

**Supervisor:** Max Birk, Assistant Professor, Department of Industrial Design, Eindhoven University of Technology, m.v.birk@tue.nl, +49 174 750 52 45

**Researcher(s):** Veerle van Wijlen, MSc Student, Industrial Design

**Purpose(s) and Objective(s) of the Research:** To increase empowerment and social integration of people with elevated trait anxiety, we investigate the effect of creative music engagement through playful musical interaction (objects) on daily relaxation capabilities, offering support to negative thinking.

### Procedures:

Phase 1: Introduction of the experts in the meeting.

Phase 2: Introduction of the project.

Phase 3: We will have an open conversation about the field of anxiety disorders, contexts and methods for relaxation, sharing experiences and expertise.

Phase 4: We will have an open discussion about possible playful musical objects for relaxation for people experiencing elevated trait anxiety.

Phase 5: We will conclude and complete the meeting.

**Funded by:** -

**Potential Risks and Benefits:** During the meeting, there are no known or anticipated risks to you by participating in this share of knowledge. Potential benefits include share of expertise and support in network in the field of design research and anxiety disorders.

**Confidentiality:**

- Confidentiality will be maintained throughout the meeting. The entire process and data will be anonymized. Data will only be presented in the aggregate and any individual comments will be anonymized prior to presentation in class or publication.
- Only the researcher will have access to the data to ensure that your confidentiality is protected.

**Audio data, and pictures:** With your permission, we would like to record audio during the meeting. The audio would be used to analyse important interview data and individual comments, which can be used as input for refining design research question, study plan and design intervention concepts and in case relevant for documentation and publication of expert insights. Please indicate if we are allowed to record audio and if the material can be presented in class and in case relevant published:

	<b>Be recorded</b>		<b>Presented anonymized</b>		<b>Used for</b>	
<b>Analysis</b>						
<b>Audio:</b>	Yes [ <input type="checkbox"/> ]	No [ <input type="checkbox"/> ]	Yes [ <input type="checkbox"/> ]	No [ <input type="checkbox"/> ]	Yes [ <input type="checkbox"/> ]	No [ <input type="checkbox"/> ]

**Used for Publication**

Yes [  ]      No [  ]

**Storage of Data:**

- Data (including audio recorded interview conversation and individual comments) will be stored on a secure password-protected server until 6 months after the end of the research and then destroyed.

**Right to Withdraw:**

- Your participation is voluntary. You may withdraw from the research project for any reason, at any time without explanation.
- Should you wish to withdraw, you may do so at any point, and we will not use your data; we will destroy all records of your data.
- Your right to withdraw data from the study will apply until the data have been aggregated (one week after study completion). After this date, it is possible that some form of research dissemination will have already occurred and it may not be possible to withdraw your data

**Follow up:**

To obtain results from the meeting, please contact Max Birk (m.v.birk@tue.nl).

**Questions or Concerns:**

- Contact the researcher(s) using the information at the top.
- This research project has been approved on ethical grounds by the Eindhoven University of Technology Research Ethics Board. Any questions regarding your rights as a participant may be addressed to that committee through the Research Ethics Office, ethics@tue.nl, +31 40 - 247 6259.

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Date, place

Signature

*Focus groups*

# Consent Form

**Title:** Anxiety and playful musical objects for relaxation

**Supervisor:** Max Birk, Assistant Professor, Department of Industrial Design, Eindhoven University of Technology, m.v.birk@tue.nl, +49 174 750 52 45

**Researcher(s):** Veerle van Wijlen, MSc Student, Industrial Design

**Purpose(s) and Objective(s) of the Research:** To increase empowerment and social integration of people with elevated trait anxiety, I investigate the effect of creative music engagement through a playful, physical, expressive and multi-sensory musical object on daily relaxation capabilities, offering support to moments of worrying and/or rumination (in other words, past-or future-oriented streams of negative thinking).

**Procedures:**

Phase 1: Welcome and Introduction, introducing the researcher and project, purpose of the focus group, why you are invited, introduction of the participants and general guidelines.

Phase 2: Individually filling out the State-Trait Anxiety Inventory form.

Phase 3: A 3-phase discussion about several topics related to the design and its underlying principle. In the first part a scenario video will be shown about possible daily situations of anxiety experiences during the day to discuss in general about; in the second part a product video will be shown explaining my design and the possible

interactions with the design to discuss about and finally a wrap-up video will be shown about the complete story of the use of the design and its underlying principle to discuss.

Phase 4: A final closure including final questions, an oral summary about the insights and remarks of the focus group, a thank you and goodbye.

Phase 5: I will send you an e-mail with a textual conclusion of the focus group.

**Funded by: -**

**Potential Risks and Benefits:** During the focus group, there are minimal known or anticipated risks to you by participating in this discussion and share of knowledge. Data retrieved about the participant's level of anxiety from the STAI will be analyzed after focus groups have been taken place, will be done anonymously and only used for the sake of analysis within this design research. The coded data of the discussion responses and STAI results, will be kept on a password protected academic online platform at the Eindhoven University of Technology. All the personal data collected during the study will be processed confidentially and you, as participant, will never be recognizable in publications, academic material or any other means. Quotes from the focus group discussions will be pseudonymized and screened for not being traceable to an individual.

Potential benefits include discussion insights and share of expertise in the field of design research and design for anxiety in general.

**Confidentiality:**

- Confidentiality will be maintained throughout the focus group. The entire process and data will be anonymized. Data will only be presented in the aggregate and any individual comments will be anonymized prior to presentation in class or publication.
- Only the researcher will have access to the data to ensure that your confidentiality is protected.

**Audio data and video data:** With your permission, I would like to record audio and/or video during the focus group. The audio and video data would be used to analyse important discussion responses and individual comments, which can be used as input for concluding the potential of the design for relaxation and in case relevant for documentation and publication of focus group insights. Please indicate if I am allowed to record audio and/or video, if the material can be presented in class and in case relevant published:

	<b>Be recorded</b>		<b>Presented anonymized</b>		<b>Used for</b>	
<b>Analysis</b>						
<b>Audio:</b>	Yes [ ]	No [ ]	Yes [ ]	No [ ]	Yes [ ]	No
[ ]						

**Used for Publication**

Yes [ ]      No [ ]

	<b>Be recorded</b>		<b>Presented anonymized</b>		<b>Used for</b>	
<b>Analysis</b>						
<b>Video:</b>	Yes [ ]	No [ ]	Yes [ ]	No [ ]	Yes [ ]	No
[      ]						

**Used for Publication**

Yes [ ]      No [ ]

**Storage of Data:**

- Data (including audio and/or video recorded discussion conversation and individual comments) will be stored on a secure password-protected server until 12 months after the end of the research and then destroyed.

**Right to Withdraw:**

- Your participation is voluntary. You may withdraw from the research project for any reason, at any time without explanation.
- Should you wish to withdraw, you may do so at any point, and we will not use your data; we will destroy all records of your data.
- Your right to withdraw data from the study will apply until the data have been aggregated (one week after study completion). After this date, it is possible that some form of research dissemination will have already occurred and it may not be possible to withdraw your data

**Follow up:**

To obtain results from the meeting, please contact Max Birk (m.v.birk@tue.nl)

**Questions or Concerns:**

- Contact the researcher(s) using the information at the top.
- This research project has been approved on ethical grounds by the Eindhoven University of Technology Research Ethics Board. Any questions regarding your rights as a participant may be addressed to that committee through the Research Ethics Office, ethics@tue.nl, +31 40 - 247 6259.

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Date, place

Signature

*Expert interview*

# Consent Form

**Title:** Anxiety and playful musical objects for relaxation

**Supervisor:** Max Birk, Assistant Professor, Department of Industrial Design, Eindhoven University of Technology, m.v.birk@tue.nl, +49 174 750 52 45

**Researcher(s):** Veerle van Wijlen, MSc Student, Industrial Design.

**Purpose(s) and Objective(s) of the Research:** To increase empowerment and social integration of people with elevated trait anxiety, I investigate the effect of creative music engagement through a playful, physical, expressive and multi-sensory musical object on daily relaxation capabilities, offering support to moments of worrying and/or rumination (in other words, past-or future-oriented streams of negative thinking).

## Procedures:

Phase 1: Welcome and Introduction, small recap and update of the project, purpose of the interview, introduction of the interview, introduction of the design and underlying design principle and general guidelines.

Phase 2: First impression of the product video (sent upfront to you via e-mail).

Phase 3: A 2-phase discussion about several topics related to the design and its underlying principle. In the first part we will discuss the product video, explaining the design and the possible interactions, in more detail, just as the underlying principle of the design. In the second part we will discuss opinions and perspectives on how to bring design into clinical practice (in general and in the field of anxiety disorders, worrying and/or rumination) and on the role of physical, expressive and multi-sensory designs in therapeutic contexts.

Phase 4: A final closure including final questions, an oral summary about the insights and remarks of the interview, a thank you and goodbye.

**Funded by:** -

**Potential Risks and Benefits:** During the interview, there are minimal known or anticipated risks to you by participating in this share of knowledge. The coded data of the interview responses will be kept on a password protected academic online platform at the Eindhoven University of Technology. All the personal data collected during the study will be processed confidentially and you, as expert

taking part in this interview, will never be recognizable in publications, academic material or any other means, unless you give consent for revealing your name (see below). The same holds for quotes from the interview conversation which will be pseudonymized and screened for not being traceable to an individual, unless you give consent for revealing your name (see below).

Potential benefits include share of expertise and support in network in the field of design research and anxiety disorders, worrying and/or rumination.

**Confidentiality:**

- Confidentiality will be maintained throughout the interview. The entire process and data will be anonymized. Data will only be presented in the aggregate and any individual comments will be anonymized prior to presentation in class or publication.
- Only the researcher will have access to the data to ensure that your confidentiality is protected.

**Audio data:** With your permission, I would like to record audio during the interview. The audio data would be used to analyse important conversation responses and individual comments, which can be used as input for concluding the potential of the design for relaxation in the field of anxiety and in case relevant for documentation and publication of expert interview insights. Please indicate if I am allowed to record audio, if the material can be presented in class and in case relevant published:

	<b>Be recorded</b>		<b>Presented anonymized</b>		<b>Used for</b>	
<b>Analysis</b>						
<b>Audio:</b>	Yes [ ]	No [ ]	Yes [ ]	No [ ]	Yes [ ]	No
[ ]						

**Used for Publication**

Yes [ ]      No [ ]

**Personal data:** With your permission, I would like to present interesting insights and quotes from the interview in publications, academic material or any other means, connected to your first and last name, in case you give consent for this. Otherwise, in case you do not give consent for revealing your name, as stated above, you will never be recognizable in publications, academic material or any other means and quotes from the interview conversation which will be pseudonymized and screened for not being traceable to an individual.

	<b>Used for Presentation</b>		<b>Used for Publication</b>	
<b>First and last name:</b>	Yes [ ]	No [ ]	Yes [ ]	No [ ]

**Storage of Data:**

- Data (including audio recorded conversation and individual comments) will be stored on a secure password-protected server until 12 months after the end of the research and then destroyed.

**Right to Withdraw:**

- Your participation is voluntary. You may withdraw from the research project for any reason, at any time without explanation.
- Should you wish to withdraw, you may do so at any point, and we will not use your data; we will destroy all records of your data.
- Your right to withdraw data from the study will apply until the data have been aggregated (one week after study completion). After this date, it is possible that some form of research dissemination will have already occurred and it may not be possible to withdraw your data

**Follow up:**

To obtain results from the meeting, please contact Max Birk ([m.v.birk@tue.nl](mailto:m.v.birk@tue.nl))

**Questions or Concerns:**

- Contact the researcher(s) using the information at the top.
- This research project has been approved on ethical grounds by the Eindhoven University of Technology Research Ethics Board. Any questions regarding your rights as a participant may be addressed to that committee through the Research Ethics Office, [ethics@tue.nl](mailto:ethics@tue.nl), +31 40 - 247 6259.

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Date, place

Signature

## Appendix F: Evaluation Protocols

*Focus groups hand-out*

# Focus Groups Hand-Out

## Mail contact

After recruiting, [send e-mail](#) to inform about the purpose and guidelines and ask for consent about audio/video recordings and publication.

## Introduction

Welcome, purpose, why invited, guidelines (which are already made clear in the consent forms upfront of the focus groups), roles clarification, introduction of participants);

*Introduce moderator (me & project)*

Good afternoon and welcome. Thanks for taking the time to join us to talk about the topic of anxiety and musical objects. My name is Veerle van Wijlen. Currently I am in my first year of my Industrial Design master at the University of Technology in Eindhoven. My project, in short is about the effect of an expressive and musical drum instrument on the relaxation of people experiencing anxiety on a daily basis. As you might know, many people over the world experience anxiety on a daily basis which restricts them in daily life functioning and being their best/optimal self in society. In this way they suffer from tiredness and a decreased self-image which highly asks for a need of support in relaxation. Since my design and its underlying principle, which you will get to know more about later, offer a rather new view on overcoming moments of anxiety, I wanted to gather opinions from a neutral audience with various perspectives on this topic. Your input will be used to say something about its potential for relaxation. Since I believe we have all experienced anxiety sometimes in our lives, you were invited partly because of possible experience with anxiety, and because you fall within the age group of my target audience.

There are no wrong answers, only differing points of view. Please feel free to share your point of view even if it differs from what others have said. Keep in mind that we're just as interested in negative comments as positive comments, and at times the negative comments are the most helpful.

You've probably noticed the record button here. I am recording the session because I don't want to miss any of your comments. People say really helpful things in these discussions and I can't write fast enough to get them all down. We will be on a first name basis tonight, and I won't use any names in our reports. I will keep what you say confidential. [[Start recording audio/video!](#)]

I've got a number of questions that I want to ask, but my job is really to listen. This will be more interesting for all of us if we treat this like a conversation. If someone says something, feel free to follow up on it or share a different point of view. You don't need to address all your comments to me.

If you have a cell phone, please put it on silent mode. If you need to take a call, please step out and then return as quickly as possible. If there is any other reason to leave the call, please feel free to do so.

Let's begin. We are all able to see each others names which will help us remember them. Let's find out more about each other by going around the table. Tell us your name, your current function and what you like doing on a daily basis?.

### **State Trait Anxiety Inventory**

Explain what it is and why I am doing this and what I am gonna use it for.

If you have filled in the questionnaire, please mention to me if you are back by stating something in the chat or wave your hand as a reaction. If any questions or problems arise, please say so and don't discuss any items please while filling in with each other. This is an individual assignment.

[Link to questionnaire \(STAI\)](#)

[This link has been left out of this appendix, the questionnaire can be reviewed in the follow-up appendix.](#)

Any questions? Does it all work?

### **3-phase Discussion**

In this second part I would like you to discuss upon several topics related to my design and the underlying principle. Therefore this discussion will be divided into 3 phases. In the first part I will show you a scenario video about possible daily situations of anxiety experiences during the day to discuss in general about; in the second part I will show you a product video explaining my design and the possible interactions with the design to discuss about and finally I will show you a wrap-up video that shows the complete story of the use of the design and underlying principle to discuss. Is this all clear for everyone? Any further questions before we start?

Let's begin!

#### *Scenario Video Discussion*

First I am going to show you a scenario video about a possible daily situations of anxiety experiences to discuss about.

[Send link to scenario video \(on Vimeo or Youtube\)](#). If you are back, please let me know in the video conference via the chat, a reaction or quickly say something. While watching the video, please mute

your microphone.

<https://drive.google.com/file/d/1O8ivG7zm-d0OAhHo4ddZBJ9Z-O785gyk/view?usp=sharing>

Starting the discussion:

So you have now all seen the video, can anyone tell me how you can relate **in general** to what you have seen? Or to moments / feelings of anxiety **in general**? **Just understand they might in general also experience anxiety, gives context around discussion responses.** In case not relatable, do you know anybody who could relate to this? And how?

NO PERSONAL STORIES, UP TO THEM.

Who else? / Are there comments from anyone else?

Is there anyone who has experience with meditation or mindfulness? Would you like to elaborate on this? Anyone else?

So are there other ways to deal with anxiety? Carve towards expressivity.

Tell story about my expressive design à next session.

### *Product Video Discussion*

Showing product explanation and possible interactions with the design (to build up towards musical and expressive crescendo).

There are namely next to the more calming and soothing methods for relaxation, also more expressive ways to deal with daily experiences of anxiety. In my project I focus on a self-made musical drum instrument to research a more expressive way for relaxation. And the design of this drum instrument is based on the principle of tension and release to relax. Can anyone of you imagine what I mean with tension and release if you think about relaxation?

Well, what I mean is that with this drum instrument it is possible to build up to a highlight of tension, also called an expressive crescendo, from which to flow into relaxation (and so release build up tension through responses to anxiety). This is basically the underlying principle of my design, so I will now give you the link to a video explaining and showing the design and possible interactions with it which we will discuss.

[Send link to product video \(on Vimeo or Youtube\)](#). If you are back, please let me know in the video conference via the chat, a reaction or quickly say something. While watching the video, please mute your microphone.

<https://drive.google.com/file/d/11w392rhTV9zatvz-IX5ASv-4OUTNNA31/view?usp=sharing>

Starting the discussion:

### *First impression*

1. What is your first impression of the design of the drum instrument?

2. What is your first impression of building towards a musical crescendo with this drum instrument?

### Interaction(s)

1. Who could say something about the interactions with the drum instrument?
2. How would these interactions support building up towards a crescendo? How not? Why?
3. How would these interactions support in relaxation? How not? Why?
4. How would you like to interact with it? Why?
5. What do you think of the interactions that are possible? Why? Would it be possible to build towards a crescendo with these?
6. How would you build up towards a crescendo with this instrument? Why?

Who else?

### Musical tones

1. What did you hear when musical tones were played?
2. Opinion on the musical tones / musical interaction? (creating tension & release)
3. Opinion on the shape of the tongues, their meanings, the chosen ones?

### Light guidance

1. Opinion on the light interaction, functions, placing etc.? (warmer, colder, feedback in how you build up crescendo)

### General

1. Opinion on the shape of the instrument?

Wow, thank you all for your feedback and input, that was a great discussion! I think it is time to move on to the final discussion part.

So what's next? Well, let's go to the wrap-up discussion.

### *Wrap-Up Video Discussion*

In this final phase of the discussion I am going to show you a video that shows the complete story around the design, so basically the general principle underlying the design to discuss about.

[Send link to wrap-up video \(on Vimeo or Youtube\)](#). If you are back, please let me know in the video conference via the chat, a reaction or quickly say something. While watching the video, please mute

your microphone.

[https://drive.google.com/file/d/1HNRv3J\\_-Hhys6JfXHOvBJBV95B58ePf3/view?usp=sharing](https://drive.google.com/file/d/1HNRv3J_-Hhys6JfXHOvBJBV95B58ePf3/view?usp=sharing)

Starting the discussion:

#### Future use

1. How would you see yourself using the drum instrument, using this?
2. How would you see yourself using (in) the Tension Release concept?
3. Or do you see this in another context?

#### Possible effect

1. How would you see the effect of playing this drum instrument?

How would building up expressively and musically towards a crescendo with this drum support in relaxation? How not? Why?

How would building up expressively and musically towards a crescendo with this drum support the general Tension Release principle? How not? Why?

What do you think of the Tension Release principle for relaxation to overcome moments of worrying/rumination/and so anxiety? Why?

How would building up expressively and musically towards a crescendo with this drum support in overcoming moments of worrying/rumination/anxiety? How not? Why?

What do you think about the context of the design (at home)? Why?

#### Closure

Are there any final questions?

Oral summary to the group & reactions on that.

Send you an e-mail with the summary of today's focus group.

Thank you for your time and great input and goodbye.

[Stop audio & video recording!](#)

*Final expert interview hand-out*

# Expert Interviews Hand-Out

**Mail contact**

After recruiting, [send e-mail](#) to inform about the purpose and guidelines and ask for consent about audio/video recordings and publication.

[Send video upfront](#) so they have seen it already once or a couple of times.

## **Introduction**

[Start audio recording \(already filled in consent for this\)](#).

Hi Julian / Hi David / Welcome Max! Good to see you all again!

I am very glad and pleased that you could still make some time for me, for this expert interview!

Therefore, I am doing great!

So how is everyone doing?

Wrap-up after last time: so I have updated you off course on my project, and I have sent you the video of the final design, but just as a quick recap of what I have been doing since last time we have met is basically that I have chosen a final design concept, worked that out, prototyped the design, made the explanatory video and prepared the evaluations with you and some focus groups to discuss about the potential of the design for relaxation amongst people with elevated trait anxiety who experience daily worrying and/or rumination. Next to that I have prepared some more general questions for you about the future role of design in therapy contexts.

So compared to last meeting, I would like to have your opinion and perspective on the integration of all my gathered insights in the first phase in which you were involved to say something about the potential of my design for relaxation amongst people with elevated trait anxiety, usage in clinical practice and therapy contexts.

Therefore, I have prepared a video prototype of the final design about how it works and possible interactions with it. Next to that I have prepared some guiding topics for this “interview”, it is more an open-ended conversation in which my job is to really listen and hear your perspective on my design and its underlying principle.

So, what I believe is most novel and interesting about this design is the fact that there are next to the more calming and soothing methods for relaxation, also more expressive ways to deal with daily experiences of anxiety. Therefore, in my project I focus on a self-made musical drum instrument to research a more expressive way for relaxation. And the design of this drum instrument is based on the principle of tension and release to relax. Can you imagine what I mean with tension and release if you think about relaxation?

Well, what I mean is that with this drum instrument it is possible to build up to a highlight of tension, also called an expressive crescendo, from which to flow into relaxation (and so release build up tension through responses to anxiety). This is basically the underlying principle of my design, so I will now discuss the video I have sent you in which I tried to explain the design and possible interactions with it.

## First impression

1. What was your first impression after you had watched the video?
2. What is your first impression of the design of the drum instrument?
3. What is your first impression of building towards a musical crescendo with this drum instrument?

If not watched, watch at the moment: [send link](#).

<https://drive.google.com/file/d/11w392rhTV9zatvz-IX5ASv-4OUTNNA31/view?usp=sharing>

## 2-phase Discussion

1 (video)prototype will be discussed using prepared open-ended questions as in a semi-structured interview:

*Design focused questions / interactions for crescendo building:*

### Interaction(s)

1. What could you say about the interactions with the drum instrument?
2. What could you say about the expressiveness in the design? (how expressive can they be? What do you think of an expressive design?)
3. How would these interactions support building up towards a crescendo? How not? Why?
4. How would these interactions support in relaxation? How not? Why?
5. How would you / your patients like to interact with it? Why? (How do you imagine it happening / envision it? E.g. at home, after therapy etc.)
6. What do you think of the interactions that are possible? Why? Would it be possible to build towards a crescendo with these?
7. How would you / your patients build up towards a crescendo with this instrument? Why?

### Musical tones

1. What did you hear when musical tones were played?
2. Opinion on the musical tones / musical interaction? (creating tension & release, chosen tones (happy scale))
3. Opinion on the shape of the tongues, their meanings, the chosen ones, how they guide the interaction of musical tension and release?

## Light guidance

1. Opinion on the light interaction, functions, placing etc.? (warmer, colder, feedback in how you build up crescendo)

## General

1. Opinion on the shape of the instrument? (size, sturdiness, material use)

*Focus on the principle underlying the design:*

## Future use

1. How would you see yourself / patients using the drum instrument, using this?
2. How would you see yourself / patients using (in) the Tension Release concept?
3. Or do you see this in another context?

## Possible effect

1. How would you see the effect of playing this drum instrument?
2. How would you see the effect of building towards a musical, expressive crescendo?
3. How would you see the support this drum instrument gives people with elevated trait anxiety?

## More in-depth questions

1. How would building up expressively and musically towards a crescendo with this drum support in relaxation? How not? Why?
2. How would building up expressively and musically towards a crescendo with this drum support the general Tension Release principle? How not? Why?
3. What do you think of the Tension Release principle for relaxation to overcome moments of worrying/rumination/and so anxiety? Why?
4. How would building up expressively and musically towards a crescendo with this drum support in overcoming moments of worrying/rumination/anxiety? How not? Why?
5. What do you think about the context of the design (at home)? Why?

## Role of design in clinical practice and in therapy contexts

### *Bringing design into clinical practice*

1. What is your opinion on how to bring design into clinical practice (in general and in the field of anxiety disorders, worrying and rumination)? And the role of design into clinical practice?
2. Since this design can be used to support people who are in therapy for their worrying/rumination/anxiety disorder and can be used from a clinical practitioners perspective as a tool to recommend in therapy programs, how do you see the interplay between clinical practice and design happening in the future?
  - a. How do you see the role of design in clinical practice from the perspective of people with elevated trait anxiety? (2<sup>nd</sup> layer, can never be them which limits their perspective taking)
  - b. How do you see the role of design in clinical practice from the perspective of therapists / clinical practitioners?

*Role of physical, expressive and multi-sensory design in therapeutic contexts*

3. How would you see the role of physical, expressive and multi-sensory designs or designs that contain one / two of these aspects in therapeutic contexts in the future? Do you have any thoughts on how this could open up a new avenue in your field.

**Closure**

Are there any final questions?

Oral summary to the group & reactions on that.

Send you an e-mail with the summary of today's focus group.

Thank you for your time and great input and goodbye.

[Stop audio & video recording!](#)

## Appendix G: State-Trait Anxiety Inventory

# State-Trait Anxiety Inventory (STAI)

Dear focus group participant,

This self-reported questionnaire is used to get a general indication of your current anxiety level before the participation of this focus group. Based on this information, the researcher is able to better perform analysis of the discussion responses of the focus group. Data retrieved about your level of anxiety from the STAI will be analyzed after focus groups have been taken place, will be done anonymously and only used for the sake of analysis within this design research. The coded data of the STAI results, will be kept on a password protected academic online platform at the Eindhoven University of Technology. All the personal data collected during the study will be processed confidentially and you, as participant, will never be recognizable in publications, academic material or any other means.

### 1. Participant Number \*

*Please fill in a unique number containing your initials, birthday and the date of participation in one number, in the order as mentioned (e.g. AB1107199819052020)*

2. STAI - Trait : rate the following items presented underneath \* 

*A number of statements which people have used to describe themselves are given below. Read each statement and then, using the scale below, indicate how you generally feel. There are no right or wrong answers. Do not spend too much time on any one statement, but give the answer which seems to describe how you generally feel.*

	Strongly disagree	Disagree	Agree	Strongly agree
I feel pleasant	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel nervous and restless	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel satisfied with myself	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I wish I could be as happy as others seem to be	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel like a failure	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel rested	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am calm, cool, and collected	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel that difficulties are piling up so that I cannot overcome them	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

I worry too much over something that really doesn't matter	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I have disturbing thoughts	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I lack self-confidence	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I make decisions easily	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel inadequate	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am content	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Some unimportant thought runs through my mind and bothers me	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I take disappointments so keenly that I can't put them out of my mind	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am a steady person	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel confused	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel steady	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

I get in a state of tension or turmoil as I think over my recent concerns and interest

3. STAI - State : rate the following items presented underneath \* 

*A number of statements which people have used to describe themselves are given below. Read each statement and then, using the scale below, indicate how you feel right now, that is, at this moment. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe your present feelings best.*

	Strongly disagree	Disagree	Agree	Strongly agree
I feel calm	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel secure	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am tense	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel strained	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel at ease	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel upset	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am presently worrying over possible misfortunes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am satisfied	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel frightened	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel comfortable	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

I feel self-confident	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel nervous	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am jittery	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel indecisive	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am relaxed	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel content	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am worried	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel confused	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel steady	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel pleasant	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Verzenden

## Appendix H: Video Probes

### *Scenario Video*

<https://drive.google.com/file/d/1O8ivG7zm-d00AhHo4ddZBJ9Z-O785gyk/view?usp=sharing>

### *Design Video*

<https://drive.google.com/file/d/11w392rhTV9zatvz-IX5ASv-4OUTNNA31/view?usp=sharing>

### *Wrap-up video*

[https://drive.google.com/file/d/1HNRv3J\\_-Hhys6JfXHOvBJBV95B58ePf3/view?usp=sharing](https://drive.google.com/file/d/1HNRv3J_-Hhys6JfXHOvBJBV95B58ePf3/view?usp=sharing)

## Appendix I: Thematic Analysis

Participants are not mentioned after the quotes in the analysis Excel sheet and participant STAI scores are made invisible due to privacy. These can be obtained when requested.

“Only Read” link to the Excel analysis document:

<https://docs.google.com/spreadsheets/d/1ggtoA0wBPENkESNm6p3QMU993YvONYp5nVjkr1uWRw/edit?usp=sharing>

Furthermore, in-depth investigation of sub theme 1 ‘design context and use’ within theme 3 ‘design integration’ is provided.

### *Theme 1, sub theme 3: Relaxation effects*

Further discussions revealed experienced durations of the relaxation effects. One participant in group 2 stated about the duration of the effect, “*When I do it in the morning I think I feel the effect for about 3 hours! Until lunch.*” (P6, G2) and the difference in effect when doing the same relaxation activity in the evening, as support in sleep, “*In the evenings it is just nice because you then go to bed and totally relaxed before going to sleep.*” (P6, G2).

### *Theme 3, sub theme 1: Design context and use*

When the participants of both focus groups were asked how they would see themselves using the drum, and to imagine other use contexts then at home, in each group, discussions were raised about the *moment of use*, *what to use it for*, *use frequencies* and the *context of use*. Especially in focus group 1, the moments of use were discussed elaborately. The three participants in this group all discussed different moments during the day to use the design, just as different purposes within the field of relaxation. One of the participants in group 1 stated to use it at work or when being busy to take a break, “*I would use it while being at work, busy at home, to focus on something else, otherwise I can go on forever.*” (P2, G1). One of the other participants in this group could relate to using it as a break, really schedule this break, but more after a long day of working, and stated, “*I would use it at the end of the day, schedule it as a break.*” (P1, G1). This latter participant stated the break with this design

would have the purpose to re-energize, *"I would use it in the afternoon for re-energizing myself."* (P1, G1). Another participant in group 1 mentioned to prefer using it before going to bed, and stated interesting enough with the purpose to relieve from "stress that has no purpose", *"I would use it before going to bed to relax, when stress has no purpose for me."* (P3, G1).

As already mentioned within the first theme, participants in group 2, preferred physical activity as support in relaxation, because it does not have relaxation as prior goal. A similar way of use for RELAX-CHANGE is suggested by participants in group 2. One of these participants stated about this, *"I wouldn't use it with relaxation as main goal in my mind."* (P6, G2). Related to this, another participant in group 2 made a remark about the fact RELAX-CHANGE allows for more freedom in use, and stated, *"There is some more freedom in playing this instrument."* (P4, G2).

One of the 6 key insights from the first theme was that optimized play patterns could lead to positive benefits for relaxation. What was discussed in focus group 1 about the expected frequency of use amongst the participants is related to this key insight. One of the participants in group 1 states to expect a change in use frequency when optimized play, *"When you know how to optimally play, you will probably use it 1 time a day."* (P2, G1). Expert prof.dr. Julian Rubel also mentions use frequency *"depends on the user" and can be "event contingent"*. However, interestingly, expert prof.dr. Julian Rubel makes a contrasting statement about the ability of users to control the use frequency of the drum on their own, and states, *"People can also become addicted to using it, so they don't need to use it too often." and "You need to control for this use."*

In both focus groups, the participants were asked to imagine different contexts for RELAX-CHANGE. However, even before this question was asked, in every group already discussions were formed about other contexts in which they could imagine using the drum, expressing the desire for different forms of use. The participants from focus group 1 had an interesting perspective on other contexts of use, all centered around the value of connection. Participants in group 1, stated to see potential in use as a bonding exercise, *"You could do it together, connecting the mind and use it as a bonding exercise."* (P3, G1) or for connecting partners in couples therapy, *"It could be used for couples therapy, connecting partners better together."* (P1, G1) or in therapy contexts, *"It could be used in a therapist office, to connect therapy with relaxation at home."* (P2, G1). This will also be discussed in the next sub theme and the 'Discussion' section. Contrastingly, participants in group 2, mainly discussed to see potential using the design in public space. One of the participants from this group stated about using the drum in the squad spaces, *"You could use it for example in the squad spaces with headphones so others are not interrupted by it so you can use it in public."* (P7, G2). One of the other participants agreed and was reminded to the use of pianos in train stations, and stated, *"The public space thing reminds me of pianos in the stations."* (P4, G2).

## **Appendix M: ERB form**

# Ethical Review Form

(Version 27.06.2019)

This Ethical Review Form should be completed for every research study that involves human participants or personally identifiable data and should be submitted before potential participants are approached to take part in the research study.

## Part 1: General Study Information

<b>1</b>	Project title	Anxiety & Musical Objects: The effect of creative music engagement through a playful interactive musical object on daily relaxation capabilities amongst people with elevated trait anxiety
<b>2</b>	Researcher	V.S. van Wijlen (Veerle)
<b>3</b>	Email researcher	v.s.v.wijlen@student.tue.nl
<b>4</b>	Supervisor(s)	Project Coach: dr. M.V. Birk
<b>5</b>	Faculty/department	Industrial Design
<b>6</b>	Research location	Eindhoven area, The Netherlands
<b>7</b>	Research period (start/end date)	May 2020 – July 2020
<b>8</b>	Funding agency	/
<b>9</b>	[If Applicable] Study is part of an educational course with code:	DEP002 Play and Learn
<b>10</b>	[If Applicable] Proposal already approved by external Ethical Review Board: Add name, date of approval, and contact details of the ERB	/
<b>11</b>	Short description of the research question	<p><b>What is the effect of creative music engagement through the use of a (home-based) playful interactive musical object (making use of expressive, multi-sensory and physical characteristics) on the relaxation, autonomy, self-competence and perceived support amongst adolescents and adults (18-35 years old) with elevated trait anxiety, as defined by the trait/state anxiety inventory?</b></p> <p>People with elevated trait anxiety experience expressions of worrying and rumination, meaning streams of negative thinking, either future-or past-oriented, difficult to control which causes tiredness and a decreased self-image (feeling of incompetence) which highly asks for a need of support in relaxation.</p> <p>Current methods to overcome moments of negative thinking, go from the principles of distraction or acceptance to either fully accept the cognitive, emotional and physical responses to worrying/rumination (not avoid, not achieve) or to guide attention more outwards, away from the thought stream e.g. by being absorbed in a certain task, and in that way provide a distracting (or mindful) outlet for negative thinking.</p>

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		<p>However, current supportive tools and designs for relaxation making use of these distraction or acceptance principles, often go from the need for comfortable, soothing, and calming experiences (such as breathing exercises, imaginary techniques or progressive muscle relaxation) but don't cover physicality, expressivity and multi-sensory musical experiences (including music engagement and mood stimulation). However, this is important to address, given the fact that moments of physical, intense expression as outlet (almost like a work-out) are really needed to break anxiety cycles as contradiction to the more calming and soothing methods. [expressivity]</p> <p>Furthermore, the response to worrying and/or rumination is multi-faceted, namely cognitive, emotional and physical which can be addressed more effectively through multi-sensory experiences [multi-sensory], helping to decrease emotional states through music engagement, decrease body tension through touch and movement and distracting from thought process through light guidance and musical play, turning attention more outwards, making use of the senses.</p> <p>Physicality enables increased, accessible, opportunities for engagement in consuming tasks (distracting/mindful) [physicality] and so dealing with moments of worrying/rumination. Furthermore, a physical object to perform a relaxation task with can increase the feeling of trust and reliability in the process of overcoming worrying/rumination, having something physical and sturdy to rely on [physicality].</p>
12	Description of the research method	<p>The study involves a combination of quantitative and qualitative research methods, with a main focus on the qualitative research methods (Mixed Methods approach). In order to explore the research question mentioned above, it will be made use of focus groups and expert interviews as part of a user-centered design approach and a research-through-design methodology.</p> <p><b>Focus Groups</b> The focus group sessions will consist each of an introduction (welcome, purpose, why invited, guidelines (which are already made clear in the consent forms upfront of the focus groups), roles clarification, introduction of participants);</p> <p>A phase to fill in the state-trait anxiety inventory and ask questions about it; a 3-phase-discussion in which 3 (video)prototypes will be discussed using prepared open-ended questions as in a semi-structured interview. These 3 (video) prototypes include a scenario video about a daily encounter with anxiety, a product video showing product</p>

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		<p>explanation and possible interactions and finally a wrap-up video concluding the design narrative;</p> <p>A closure (final questions, oral summary to the group &amp; reactions on that, thank you and goodbye).</p> <p>Each focus group will approximately last for 30-60 minutes. Furthermore, due to the COVID-19 situation, all 3 focus groups will take place in an online video conferencing environment fitting the needs and capabilities of the participants and with appropriate recording possibilities, e.g. Microsoft Teams.</p> <p><b>Expert Interviews</b></p> <p>The expert interviews will consist each out of 3 phases. These can be described as an introduction (welcome, introduction of participants, purpose, why invited, guidelines (which are already made clear in the consent forms upfront of the expert interviews), roles clarification);</p> <p>A 2-phase discussion in which 1 (video)prototype will be discussed using prepared open-ended questions as in a semi-structured interview and a semi-structured interview with open-ended questions regarding opinions on bringing design into clinical practice and the role of physical, expressive and multi-sensory design in therapeutic contexts;</p> <p>A closure (final questions, oral summary to the participants &amp; reactions on that, thank you and goodbye).</p> <p>Each expert interview will approximately last for 60-120 minutes. Furthermore, due to the COVID-19 situation, both expert interviews will take place in an online video conferencing environment fitting the needs and capabilities of the participants and with appropriate recording possibilities, e.g. Microsoft Teams or Skype.</p>
13	Description of the research population, exclusion criteria	<p><b>Focus Groups</b></p> <p>The designed (video) prototypes and research of this study target the general population. As such only people without clear intellectual or physical disabilities are solicited for this research.</p> <p>For general psychological research pertaining to playful interaction, only healthy consenting adults, within the age group of 18-40 years old, will participate. In order to fulfill the criteria of consenting adults, each participant has to sign a consent form to either give consent to participation or not and to what extent regarding audio and video recording and publication of data. In this specific COVID-19 situation it is especially emphasized on recruiting technology capable participants, who are able to work with video technologies.</p> <p>The participants for the focus groups will be recruited based on convenience and heterogeneity. Their level of</p>

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		<p>anxiety will be anonymous and only evaluated after the focus groups have been taken place, during the research analysis phase within the design research process. This to enable the researcher to link the group's anxiety diversity to the qualitative answers related to the designed (video) prototypes. It is chosen to recruit heterogenous groups of participants, since this will spark more diverse interaction amongst participants and will encourage participants to look from multiple perspectives to the presented (video) prototypes and so be better able to give valuable insights.</p> <p>Exclusion criteria:</p> <ul style="list-style-type: none"> <li>- Participants without consent</li> <li>- Participants who fall out of the age group of 18-40 years old</li> <li>- Participants with severe mental states or issues</li> <li>- Participants that are currently in therapy for anxiety related issues</li> </ul> <p><b>Expert Interviews</b></p> <p>The designed (video) prototypes and research of this study target researchers within the field of clinical psychology and clinical practitioners related to the context of worrying and/or rumination.</p> <p>For general psychological research pertaining to playful interaction, only healthy consenting adults will participate. In order to fulfill the criteria of consenting adults, each participant has to sign a consent form to either give consent to participation or not and to what extent regarding audio and video recording and publication of data.</p> <p>In this specific COVID-19 situation it is especially emphasized on recruiting technology capable participants, who are able to work with video technologies.</p> <p>Exclusion criteria:</p> <ul style="list-style-type: none"> <li>- Participants without consent</li> <li>- Participants with severe mental states or issues</li> <li>- Experts outside the field of clinical psychology, outside the field of psychology and clinical practice or outside of the context of worrying and/or rumination</li> </ul>
14	Description of the measurements and/or stimuli/treatments	<p><b>Focus Groups</b></p> <p><i>Quantitative Measurements</i></p> <p>Scores to items from the State-Trait Anxiety Inventory (STAI), in other words self-report data. This inventory consists out of statements related to State anxiety (S) and other ones related to Trait anxiety (T). Both scales have anxiety absent and anxiety present questions. Anxiety absent questions represent the absence of anxiety in a statement like, "I feel secure." Anxiety present questions reflect the presence of anxiety in a statement like "I feel worried."</p>

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	<p>These self-reported data will be obtained via Excel Sheets from the Google Forms the participants filled in, listing the self-reported answers to the 40 items in a 4-point frequency scale.</p> <p>Analysis will be done for each participant by scoring the 40 items, of the filled in STAI, based on the answers in the 4-point frequency scale and the corresponding scoring weights to their responses. The total score of each participant shows their level on the state-trait anxiety spectrum. Scores range from 20 to 80. Low scores indicate a mild form of anxiety, median scores indicate a moderate form of anxiety and high scores indicate a severe form of anxiety.</p> <p><i>Qualitative Measurements</i> During the phases of the focus groups there will be asked for first-hand reactions after showing the (video) prototypes followed by small semi-structured interviews eliciting interaction amongst the participants. Therefore, the measurements will include:</p> <ul style="list-style-type: none"> <li>- First-hand reactions of participants to the designed (video) prototypes after each phase in the focus group sessions.</li> <li>- Answers of participants to the open-ended questions asked in the semi-structured interviews after each phase in the focus group sessions.</li> </ul> <p>These will be obtained from audio and video recordings during the focus groups, only in case of participants' consent, which will only be made accessible to the researcher for transcriptions.</p> <p>Analysis will be done through thematic analysis methodology or the open coding methodology. These consist out of the following steps: familiarizing with the data (transcribing), generating initial codes (interesting features of the data), searching for themes (overlapping themes in the codes), reviewing themes (check if themes work related to the abstracted codes), defining and naming themes (specifics of each theme), producing final report / results (what does it mean, interpretation).</p> <p><b>Expert Interviews</b> <i>Qualitative Measurements</i> Answers of experts to the open-ended questions asked in the semi-structured interview after the (video) prototypes are demonstrated and shown.</p> <p>These will be obtained from audio recordings during the expert interviews, only in case of participants' consent, which will only be made accessible to the researcher for transcriptions.</p> <p>Analysis will be done through thematic analysis methodology or the open coding methodology. These consist out of the following steps: familiarizing with the</p>
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		data (transcribing), generating initial codes (interesting features of the data), searching for themes (overlapping themes in the codes), reviewing themes (check if themes work related to the abstracted codes), defining and naming themes (specifics of each theme), producing final report / results (what does it mean, interpretation).
<b>15</b>	Number of participants	<p><b>Focus Groups</b> 3 repeated focus groups with each 6-8 different participants maximum.</p> <p><b>Expert Interviews</b> 2 expert interviews with each 2 participants maximum.</p>
<b>16</b>	Explain why the research is socially important. What benefits and harm to society may result from the study?	<p>This design research is socially important, since:</p> <p>Individual freedoms at the core of modern democratic systems have brought improved quality of life to their citizens. These include amongst others freedom of expression, freedom of worship and freedom of fear. However, for people with elevated trait anxiety these freedoms are particularly challenging in daily life. The main problems related to anxiety, of worrying and/or rumination, causing difficulties in relaxation and a decreased self-image, cause restrictions in daily life functioning and so in being their 'best self' in society. In this way a decrease in quality of life and well-being through lack of freedom, empowerment and social integration is caused which needs to be addressed.</p> <p>Next to individual gains which can be made, additional societal benefits from increase in empowerment and in social integration are a decrease in the high healthcare costs and burden of anxiety in society.</p> <p>This design research provides a low-risk, online and safe setting where participants voluntarily and playfully engage into discussions and interviews about designs for anxiety in a fun, interactive and low-effort manner. In this way, they subsequently learn and share knowledge possibly improving their critical attitude towards dealing with anxiety on a personal and societal level.</p>
<b>17</b>	Provide a brief statement of the risks you expect for the participants or others involved in the research or educational activity and explain. Take into consideration any personal data you may gather and privacy issues.	<p>This study involves minimal risks for the participants. None of the participants will be directly involved with any physical prototype which prevents any risks related to CE approved components. Furthermore, both focus groups and expert interviews will take place in a digital video conferencing environment. This allows participants to engage from a private, comfortable and safe environment.</p> <p>Next to this, recruitment of participants for the focus groups is done based on convenience and not based on requested or specified anxiety conditions or characteristics. As mentioned, in part 13, data about the participant's level of anxiety from the STAI will be analyzed after focus groups have been taken place, will</p>

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		<p>be done anonymously and only used for the sake of analysis within this design research. Together with informing about the purpose, procedures and guidelines of the study and the use of consent forms upfront of participation, the risk of involving people with severe anxiety problems will be low.</p> <p>Participants in both focus groups and expert interviews will not be exploited and the research plan will be fully revealed before the start of the study. The researchers will have access to this data only with prior consent from the participants, who can decline to share their results at any moment.</p> <p>All participants will be expressly notified that they may go out of the study (online video setting) at any moment at no penalty, and the study is set up in such a way that there is no barrier to do this.</p> <p>The focus group discussions and expert interviews conducted within the research-through-design approach will be focused exclusively on the usage and experience of the prototype presented in the videos and the evaluation of the concept behind the design. For collecting more sensitive personal information, an amendment to this proposal will be needed.</p> <p>Additionally, the tasks that will be asked from participants in both focus groups and expert interviews, in order to engage in the research and discuss about the (video)prototypes, will be such that they do not deviate from regular activities in the specified context and research.</p> <p>Self-reported data from the STAI will be coded, as mentioned in part 14, and allocated a randomized number. The coded data will be kept on a password protected academic online platform at the Eindhoven University of Technology. All the personal data collected during the study will be processed confidentially and test subjects will never be recognizable in publications, academic material or any other means. Quotes from the expert interviews and focus group discussions will be pseudonymized and screened for not being traceable to an individual.</p> <p>Finally, no individual quantitative results will be published, as conclusions will be made from the entire cohort's data. The results of this study will be disseminated in scientific conferences and published in scientific research journals.</p>
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### Part 2: Checklist for Minimal Risk

		Yes	No
<b>1</b>	Does the study involve participants who are particularly vulnerable or unable to give informed consent? (e.g. children, people with learning difficulties, patients, people receiving		x

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	counselling, people living in care or nursing homes, people recruited through self-help groups)		
2	Are the participants, outside the context of the research, in a dependent or subordinate position to the investigator (such as own children or own students)?		X
3	Will it be necessary for participants to take part in the study without their knowledge and consent at the time? (e.g. covert observation of people in non-public places)		X
4	Will the study involve actively deceiving the participants? (e.g. will participants be deliberately falsely informed, will information be withheld from them or will they be misled in such a way that they are likely to object or show unease when debriefed about the study)		X
5	Will the study involve discussion or collection of personal data? (e.g. name, address, phone number, email address, IP address, BSN number, location data) or will the study collect and store videos, pictures, or other identifiable data of human subjects? <sup>1</sup> . Please check the FAQ's on the <a href="#">intranet</a> . <u>If yes</u> : please follow the <a href="#">procedure</a> . Make sure you perform a Data Protection Impact Assessment (DPIA) and make a Data Management Plan if necessary and let the <a href="#">data steward</a> check it.	X	
6	Will participants be asked to discuss or report sexual experiences, religion, alcohol or drug use, or suicidal thoughts, or other topics that are highly personal or intimate?		X
7	Will participating in the research be burdensome? (e.g. requiring participants to wear a device 24/7 for several weeks, to fill in questionnaires for hours, to travel long distances to a research location, to be interviewed multiple times)?		X
8	May the research procedure cause harm or discomfort to the participant in any way? (e.g. causing pain or more than mild discomfort, stress, anxiety or by administering drinks, foods, drugs)		X
9	Will blood or other (bio)samples be obtained from participants (e.g. also external imaging of the body)?		X
10	Will financial inducement (other than reasonable expenses and compensation for time) be offered to participants?		X
11	Will the experiment involve the use of physical devices that are not 'CE' certified?		X

**Important:**

If you answered all questions with "no", you can skip parts 3 - 4 and go directly to part 5. Check which documents you need to enclose and continue with signature and submission.

If you answered one or more questions with "yes", please continue with parts 3 – 5.

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### Part 3: Study Procedures and Sample Size Justification

<p><b>1</b></p>	<p>Elaborate on all boxes answered with “yes” in part 2. Describe how you safeguard any potential risk for the research participant.</p>	<p>In Part 2, box number 5 was answered with “yes”.</p> <p>The participants email address will be collected. The data is stored on a university platform. The email address will be used to share the qualitative data and conclusions of the expert interview or focus group between participants and researchers and will not be shared with third parties.</p> <p>Regarding the collection of personal data, as mentioned in Part 1 number. 17, The self-reported data from the STAI will be coded, as mentioned in part 14, and allocated a randomized number. The coded data will be kept on a password protected academic online platform at the Eindhoven University of Technology. All the personal data collected during the study will be processed confidentially and participants will never be recognizable in publications, academic material or any other means. In this way any risk regards collection of personal data that might lead back to any participating individual is safeguarded.</p> <p>Furthermore, audio recordings and possibly video recordings will be done during 2 expert interviews and 3 focus groups. No pictures will be made. The audio recordings, video recordings, transcripts and coded data will be kept on a password protected academic online platform at the Eindhoven University of Technology. Quotes from both expert interviews and focus group discussions will be pseudonymized and screened for not being traceable to an individual.</p> <p>Moreover, any potential risks for the participants are safeguarded by providing and discussing explicit consent forms in consultation with them via mail contact prior to the study. Participants are informed in the consent form about the collection of personal data and it is declared that some information (e.g. consent for audio or video recordings or publication) are optional to provide.</p> <p>Each participant can ask the researcher for an electronic copy of the data that she has provided or that has been measured directly at him/her. If they are dissatisfied with how data privacy is handled, they can submit a complaint to the Chief Information &amp; Security Officer, the Privacy &amp; Security Officer and/or the Data Protection Officer of the Eindhoven University of Technology via <a href="mailto:privacy@tue.nl">privacy@tue.nl</a> or contact the Dutch Data Protection Authority.</p>
<p><b>2</b></p>	<p>Describe and justify the number of participants you need for this research or educational activity. Also justify the number of observations you need, taking into account the risks and benefits</p>	<p><b>Focus Groups</b> 3 repeated focus groups with each 6-8 different participants maximum. This to divide the load for the researcher over the 3 different groups. Moreover, in this way the participant will not be involved in too large groups and so prevent potential overload or discomfort during discussions.</p> <p><b>Expert Interviews</b> 2 expert interviews with each 2 participants maximum. This to divide the load for the researcher over 2 different expert interviews and to be able to get a more deeper expert perspective in the research, interviewing the 2</p>

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		experts one-by-one, not at the same time. This may also revolve discomfort or tension for both of the experts during the interviews.
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### Part 4: Data and Privacy Statement

<b>1</b>	Explain whether your data are completely anonymous, or if they will be de-identified (pseudonymized or anonymized) and explain how	<p>As mentioned in number 1 from Part 3, regarding the quantitative data from the STAI, this will be coded, and allocated a randomized number so fully anonymized. All the personal quantitative data collected during the study will be processed confidentially and participants will never be recognizable in publications, academic material or any other means.</p> <p>Regarding the qualitative data, quotes from both expert interviews and focus group discussions will be pseudonymized and screened for not being traceable to an individual.</p>
<b>2</b>	Who will have access to the data?	Only the main applicants and their team will have access to the data.
<b>3</b>	Will you store personal information that will allow participants to be identified from their data? See <u>VSNU draft</u> .	<p><input type="checkbox"/> No  <input checked="" type="checkbox"/> Yes, and I declare I will follow the general data protection regulation (GDPR).</p> <p>The collected personal data will be retained and stored for a period of five years for retrieval and research purposes. During this period, participants can ask the researchers to withdraw the data they have provided during the study from the database of the study. Participants will be informed about the personal data collected and to their to have their data deleted. Data stored will be protected by password and limited access to ensure appropriate security, including protection against unauthorized processing or accidental loss of data. A participant can ask the researchers for an electronic copy of the data that he/she has provided or that have been measured directly at him/her. If they are dissatisfied with how data privacy is handled, they can submit a complaint to the Chief Information &amp; Security Officer, the Privacy &amp; Security Officer and/or the Data Protection Officer of the Eindhoven University of Technology via <a href="mailto:privacy@tue.nl">privacy@tue.nl</a> or contact the Dutch Data Protection Authority.</p>
<b>4</b>	Will you share de-identified data (e.g., upon publication in a public repository)?	<p><input type="checkbox"/> No  <input checked="" type="checkbox"/> Yes, and I will inform participants about how their data will be shared, and ask consent to share their data. I will, to the best of my knowledge and ability, make sure the data do not contain information that can identify participants. No individual results will be published, as conclusions will be made from the entire cohort's data. The results of this study will be disseminated in scientific conferences and published in scientific research journals.</p>

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### Part 5: Closures and Signatures

<p><b>1</b></p>	<p>Enclosures (tick if applicable):</p> <ul style="list-style-type: none"> <li><input checked="" type="checkbox"/> Informed consent form;</li> <li><input type="checkbox"/> Informed consent form for other agencies when the research is conducted at a location (such as a school);</li> <li><input type="checkbox"/> Text used for ads (to find participants);</li> <li><input type="checkbox"/> Text used for debriefings;</li> <li><input type="checkbox"/> Approval other research ethics committee;</li> <li><input type="checkbox"/> Any other information which might be relevant for decision making by ERB;</li> <li><input type="checkbox"/> Data Protection Impact Assessment checked by the privacy officer</li> <li><input type="checkbox"/> Data Management Plan checked by a data steward</li> </ul>	<p>This study will use the informed consent form approved by the University (<a href="https://intranet.tue.nl/onderzoek/ethical-review/">https://intranet.tue.nl/onderzoek/ethical-review/</a>). The form is in line with the new GDPR-requirements.</p>
<p><b>2</b></p>	<p>Signature(s)</p> <p>Signature(s) of researcher(s)</p> <p>Date: 15-05-2020</p> <p>Signature research supervisor (if applicable)</p> <p>Date 15-05-2020</p>	<p>Signature student (and researcher):</p>  <p>Signature project coach (and supervisor):</p> 