

EasyJam: Music for Everybody
(designing intimate technologies)

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July 19, 2024

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Abstract

This thesis explores intimate technologies, specifically the concept of intimacy and extimacy, through theoretical research and through designing an extimate technology prototype. Intimacy involves the "inner world" consisting of our thoughts, feelings, and experiences, while extimacy refers to the external expression of this inner world. Extimate technologies, as derived from current projects and literature, can be designed in different ways such as integrating of personal data or facilitating self-expression and communication. For this project the approach of designing intimate technologies was practised by developing a prototype that embodied the concept of intimacy and extimacy. Various ethical design thinking techniques were deployed to go from concept/theory to specific design requirements. The resulting prototype, EasyJam, provides a music-based expressive platform designed for non-musicians, enabling users to authentically convey their emotions through music, without musical skill or knowledge required.

Acknowledgement

I want to thank my supervisor Michaela Honauer and my critical observer Birna van Riemsdijk for guiding and supervising this project. Throughout this project we had many meetings which were always very useful but also enjoyable due to their supportive and passionate approach.

I also want to thank my friends and family for supporting me when times got stressful.

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Chapter 1 – Introduction

As technology evolves, the relationship between the user and their device is rapidly becoming more interactive and personal. Whether it's Smartwatches analysing our biometric data or mobile phones displaying our activity and location, various data types (biometric, location, activity, health, etc) are constantly used to personalise the individual's experience. This new personalised experience and “closeness” between the technology and the user has introduced new elements of “intimacy” in the interaction. A term previously used to describe the connection and “closeness” between humans is now coming into play when discussing technology and computing.

While there is no denying that the intimacy (between the user and their device) is innovating the personal experience, it does raise new concerns and responsibilities regarding privacy, vulnerabilities, and personal boundaries. The aim is to highlight these concerns and vulnerabilities (in intimate technology) and explore ways to design intimate technologies by understanding the concept of intimacy and extimacy (extimacy refers to intimate thoughts, data, and experiences exteriorizing themselves). The final prototype will consist of technology that embodies the concept of extimacy, allowing the user to express themselves in one way or another.

1.1 Research Question

The goal of this project is to explore the concept of intimacy and extimacy whilst applying the research in the context of technology and producing a prototype, designed to embody this concept. Therefore the main research question is:

MQ: *How can technology be designed to embody the concept of intimacy and extimacy?*

Answering this question requires exploring the concept of intimacy and extimacy, both separately and in the context of technology, leading to the following sub-questions:

SQ1: *In what ways does literature define the concepts of intimacy and extimacy?*

Exploring the concept of intimacy and extimacy serves as the foundation to explore them in the context of technology leading to the next sub-question:

SQ 2: In what ways are existing technologies designed to be intimate and extimate?

Having established the concepts through the literature and existing technologies, the next phase of this project aims to practise the approach to design intimate technology by designing a prototype. A crucial challenge during this phase is to go from theoretical concepts (such as intimacy and extimacy) to design specifications which produces the next sub-question:

SQ 3: How can theoretical concepts be effectively converted into actionable design specifications for realising a user-centred prototype?

Realising (and evaluating) the design of an extimate technology prototype that allow users to (self) express and communicate, produces the final goal and subquestion of this project:

SQ 4: How can a (extimate technology) prototype be designed to allow authentic expression?

Chapter 2 – Background Research

This section aims to lay the theoretical foundation of different literature reviews and additional research needed to conceptualise and support this project.

The first part of this literature review will focus on the concept of intimacy and extimacy, exploring different meanings and definitions that will lay the foundation for later research. The main research question driving this section is sub-question 1: *In what ways does literature define the concepts of intimacy and extimacy?* The second part will extend on the previous research while narrowing the context to technology. This section focuses on how the concept of intimacy and extimacy is embodied in a technological context and ends up answering the sub-question 2: *In what ways are existing technologies designed to be intimate and extimate?*

2.1 Definition and concept of Intimacy

The verb “intimate” can be traced back to the Latin word “intimus,” which is defined as “innermost” [1]. According to Gillerman [2], intimacy refers to the closeness and deep understanding within personal relationships, as well as familiarity and interconnectedness. It describes a state of deep emotional connection and shared knowledge between individuals, reflecting a close bond built on trust and mutual understanding. During the 18th century, the term intimacy underwent a semantic transition, defining it as an “inner feeling or consciousness” through which individuals experienced thoughts, emotions, and sensations. This shift highlighted intimacy as being an internal state rather than solely revolving around external interaction, highlighting the emotional and psychological aspects of human relationships, as well as the significance of introspections and self-awareness of one’s inner world [3]. Today, intimacy is defined as “something of a personal or private nature” and is used when describing the “closeness” or “familiarity” of human relationships [4].

The influential historian and philosopher Hannah Arendt (October 1906 - December 1975) dates the discovery of intimacy back to the period of Rousseau. Although described as something of a “private nature,” Arendt, as cited in Oliver & Keltner [5], emphasises intimacy as being “an innermost region without a place.” She states, “The intimacy of the heart, unlike the private household, has no objective tangible place in the world, nor can the society against which it protests and asserts itself be localised with the same certainty as the public space.” For Arendt the intimate is seen as a “shadowy kind of existence” and remains ultimately incommunicable, stating that “any light that illuminates the intimate in language is borrowed from the public and can never adequately mirror the intimate which remains hidden.”

2.2 Definition and concept of Extimacy

The concept of "extimacy" emerged from the French term "extimité," which was first introduced by the psychoanalyst Jacques Lacan [6] and referred primarily to “the presence of exteriority in the intimacy of the subject.” Often used in critical psychology, it serves the purpose of “problematizing, questioning, challenging, and even rejecting and going beyond the traditional psychological distinction between exteriority and psychic interiority or intimacy.” Dylan Evans and Lacan [6] refer to extimacy as blurring the lines between what's inside and outside. This idea challenges the clear boundaries between private and public, making it unclear where one starts and the other ends. Furthermore, Lacan emphasises that “extimacy is not the contrary of intimacy.” Rather, it is of the same nature but refers to an “exposed” part of the inner world. It suggests that what seems wholly private or public isn't so straightforward—it's more like a mix where the boundaries aren't clear from the start. This simple diagram (figure 1) of Lacans illustrates how the exterior is present in the interior and shows the relation that intimacy (the inside) and extimacy (the outside) have to each other.

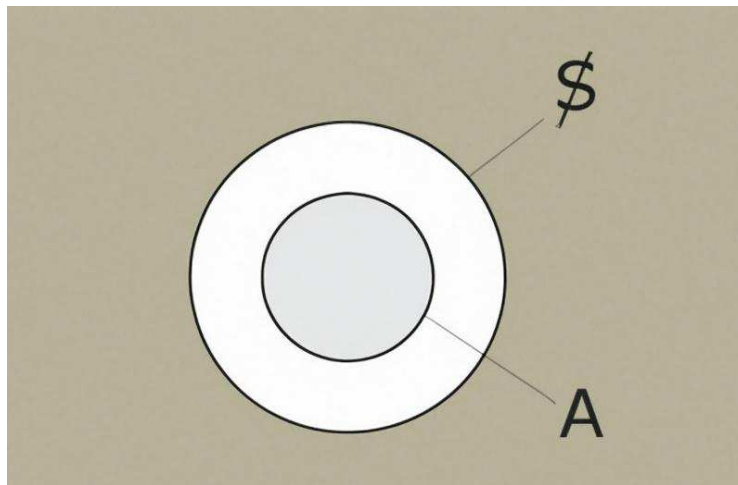


Figure 1 - Relation of Extimacy (white) vs Intimacy (gray) [7]

Extimacy has also been used to express the human desire to show or exteriorize intimate life. This illustrates another important point: even though our inner world is very personal and intimate, humans have the desire to share it and express themselves [8]. Essentially, extimacy can be described as intimate thoughts, data, and experiences exteriorizing themselves.

2.3 Intimacy and Extimacy in Relation to Technology

According to Vorstenbosch, as cited in Van Est et al [9], the concept of 'intimate technology' appears contradictory. Intimacy typically conveys human emotions such as confidentiality and connectivity, whereas technology often implies mechanistic devices devoid of life assembled using screws and bolts. Intimacy, a term previously solely used to describe the connection and “closeness” between humans, is now coming into play when it comes to technology and computing. Whether on an emotional and/or physical level, “technology is rapidly nesting itself in between us, very close to us and even within us” [9].

Van den Berg [10] characterises objects and environments to be intimate when “we live with them in intimate ways and conceive of them as having a personal meaning.” She also describes objects to be intimate when they instigate “a cycle of self-expression and self-construction.” Clothes and accessories, for instance, are used to express ourselves and construct part of our identity, making them personal and intimate. Although the term is not mentioned by Van den Berg, this is also an example of extimacy in technology, as clothes allow us to show and express part of our inner world and identity. She goes on to say that Information and communication technology are “intimate in a third sense, which other intimate objects and environments lack,” as they evoke the kind of “responses that we traditionally reserve for human-human interaction” [10].

Tomasi [11] describes the level of intimacy as the level of integration. He uses the body and mind as the closest example of an intimate relationship as one makes “use of it without thinking about it.” He states that technology “may have characteristics that allow it to be intimately experienced as we intimately experience our bodies and mind” as long as it manages to connect with “our existing body/mind/machine complex,” both socially and individually.

This level of integration can be seen as technology is increasingly becoming more personal and connected to our bodies and intimate daily lives. Mobile devices, smart wearables, and other external technologies constantly use various data types (biometric, location, activity, health, etc.) to personalise and integrate the experience.

Kapp, as cited in Aydin [12], often regarded as the pioneer of the philosophy of technology, “attempts to illustrate that technologies are essentially projections or exteriorizations of bodily organs.” His philosophy states that technological artefacts serve to augment human capabilities, mirroring mental and physical functions. For example, a hammer can be seen as an enhanced iteration of a human first, clothing mimics the protective function of skin, and railway systems replicate the structure of the vascular

system. His viewpoint highlights the symbiotic relationship between humans and technology, where technology serves as an extension of the human's nature and capabilities.

2.4 Discussion

Intimacy describes our “inner world”, consisting of our thoughts, feelings and experiences. In the context of human relationships, intimacy describes the communicating and understanding of that “inner world”. Extimacy, put simply, describes the expression of the just mentioned “inner world”. Intimacy and Extimacy are not opposites of each other but rather of the same nature, the main difference being that extimacy is defined as the exterior part of the inner world or consciousness. Since "extimacy" is a relatively recent and less familiar term, it is less frequently used when describing intimacy that exteriorizes itself. Especially in technology, the terms can often be used interchangeably as most “intimate technology” translates intimacy either through data or interaction, essentially exteriorizing it.

Various sources discuss different ways in which technology can embody the concept of intimacy and extimacy. Integrating personal data within technologies, such as biometrics, location, and activity information, allows intimacy and extimacy to manifest in a technological context. Furthermore, technologies and interfaces that encourage self-expression by enabling users to articulate their intimate thoughts and emotions provide a way of expressing our inner consciousness. Intimacy and Extimacy can also be seen in technology, which evokes human-like responses. The humanization of technology has led to technologies that replicate intimate traits and interactions that were previously only seen in human-to-human interactions. Further sources suggest that technology that seamlessly integrates into users' daily lives, as well as technologies that reflect human nature by exteriorizing human capabilities and augmenting human function and behaviours, also embody intimacy and extimacy. These technologies are becoming an extension of the users' bodies and minds and form a connection between the inner and outer world.

From the various (and just mentioned) sources on how technologies can embody intimacy and extimacy, six key design principles for extimate technologies were extracted:

1. Integration of Personal Data
2. Blurring Boundaries
3. (Self) Expression / Communication
4. Humanization of Technology
5. Seamless Integration
6. Reflect Human Nature

These principles will guide further research and eventually serve as a starting point to ideate the prototype.

2.5 Mind Map

To get an overview of the concepts and create a foundation for later brainstorming a mind map was created:

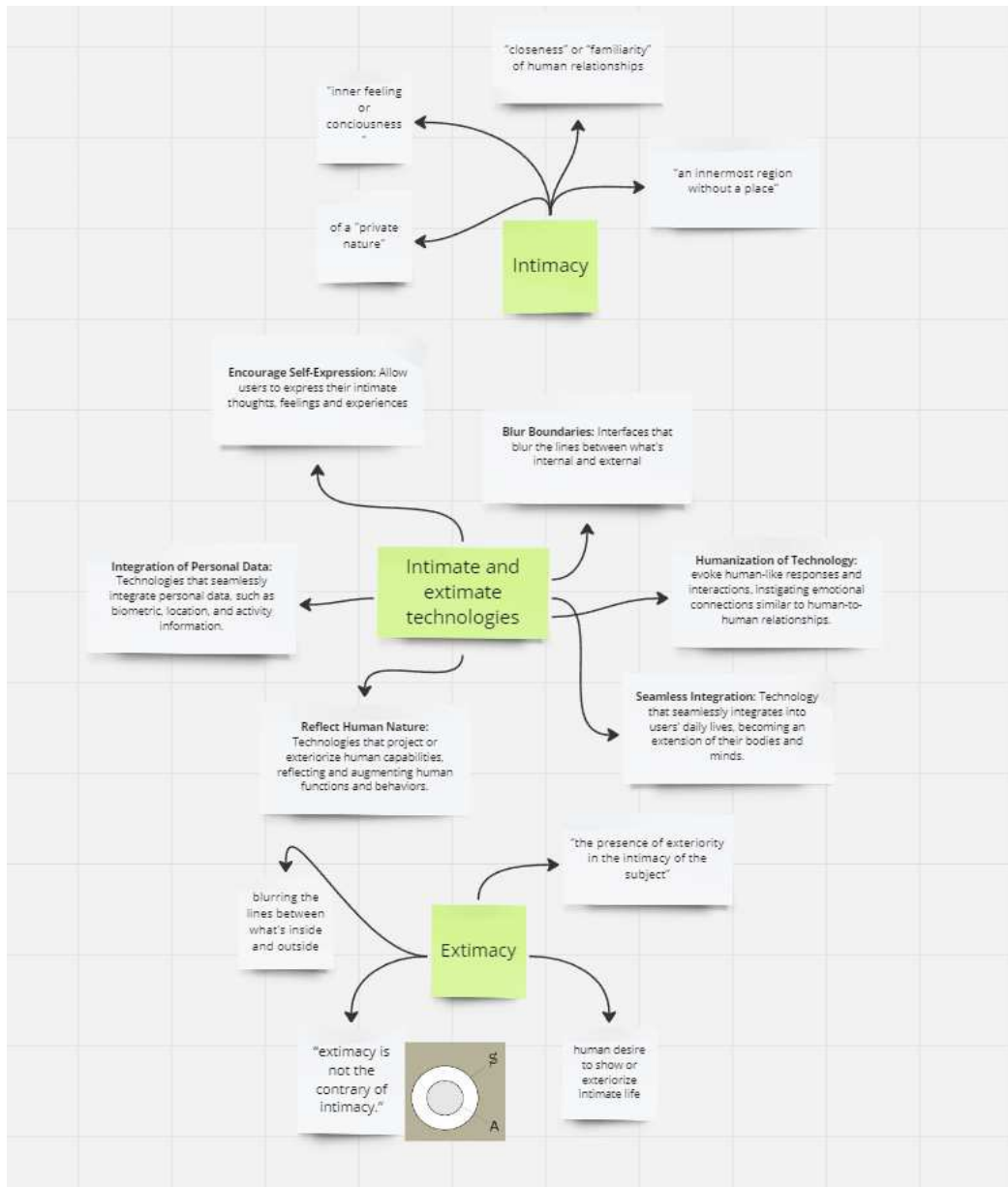


Figure 2 - Mind map of concepts and definitions

Chapter 2.2 – State of the Art (in extimate technologies)

Using the 6 criteria to design extimate technologies that were extracted from the background research (see section 2.4), a state of the art research was completed. To find and analyse these technologies the 6 criteria were used to identify extimate technologies, even if the term was not used by the designers of the projects or technologies (due to the term being rather new and not as commonly used). It should also be noted that most of these projects and technologies were analysed because they embody one or multiple of the criteria to design extimate technologies rather than focusing on the latest technological trends. This is also due to the fact that these technologies are designed in various different fields using different types of technologies. However, the technology research can be described as the state of the art in extimate technologies, analysing recent projects (with different technologies) that show the latest advancements and ways of how technology can be designed in extimate ways.

2.2.1 Intimate communication through jewelry-like wearables

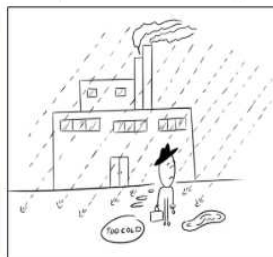
While laptops and smartphones offer direct communication methods, jewelry-like wearables present a new potential for intimate communication. Jarusriboonchai and Li's work [13] focuses on “low bandwidth ambient wearable displays as a communication channel between couples.” Their work aims to make it easier to communicate and express oneself as it's removing the complexity that might stand in the way of expressing thoughts and feelings at the time.

CONCEPTS AND STORYBOARDS



Touching on one of the symbols would make the symbol visible. The touch would also activate the same symbol on the remote bracelet.

The bracelets feature with 4 different visual symbols. Changing from one symbol to another on a bracelet could be done by directly touching the symbol. The same change would also appear on the remote bracelet belonging to the partner. The visual change would be accompanied with haptic feedback to simulate the sensation of touch from the partner. The participants suggested that this form would be more visible than a smartphone, and wearing the device on the wrist, i.e. close to hand, would resemble holding hands with their partner.



Eric is going home from his busy work day. It's raining and cold. There is no point in reaching for his phone in his trousers and fighting the harsh weather to make a phone call.



Amy is at a noisy train station. She cannot make a phone call to her beloved Eric either.



Instead, she gives a gentle touch on [the Netflix symbol] on the bracelet.



Eric feels a gentle touch from the bracelet and notices that Amy sent him an N symbol, meaning calm down it will be Netflix time for us soon.

Figure 3: Jarusriboonchai and Li's Concepts and Storyboards [13]

2.2.2 Creating personalised art through biometric data

Rafael Lozano-Hemmer creates art using biometric data [14]. Through technologies that detect heartbeats, body heat, and movement, Rafael creates unique visual and auditory experiences that explore the intersection of technology and personal identity. His art installations provoke thoughts about privacy, surveillance, and the implications of biometric technology on human behaviour and expression.

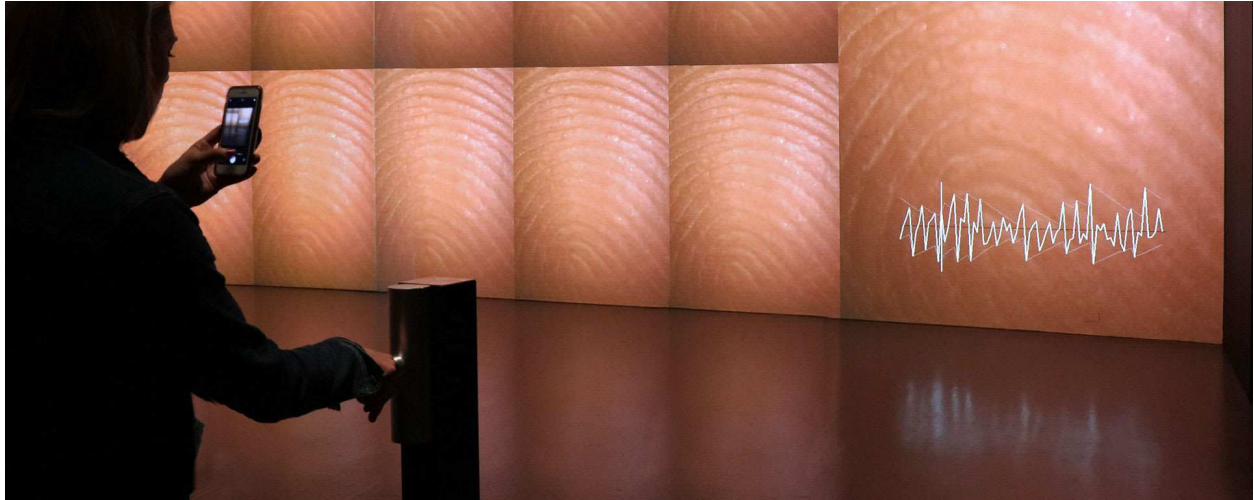


Figure 4: Pulse at the Hirshhorn Museum and Sculpture Garden [14]

2.2.3 Mission Navigation Belt

The Mission navigation belt was designed in collaboration between Elitac and the Netherlands Ministry of Defence [15]. It serves as a guiding tool that “allows soldiers to feel waypoint navigation cues through haptic feedback.” Unlike more traditional navigation tools and methods, such as visual and auditory feedback, this method allows soldiers to keep their hands, ears, and eyes free, allowing them to concentrate on their surroundings and mission.



Figure 5: Mission Navigation Belt [15]

2.2.4 FysioPal - Smarttop designed for posture

In collaboration with fashion designer Pauline van Dongen, Eliatec has designed a smart top to maintain and improve posture [16]. The wearable device monitors haptic signals around the neck, shoulders, and back, collecting data on body position and providing gentle reminders to prompt the user to maintain better posture.



Figure 6: FysioPal [16]

2.2.5 Emotion Whisperer Haptic Sleeve

“The Emotion Whisperer is a functional concept for a wearable that aims to help visually impaired people *feel* facial expressions.” Designed by Eliatec, this sleeve communicates facial expressions and emotions through haptic feedback [17]. Paired with smart glasses (worn by the user), the sleeve can communicate various emotions through vibrations in different patterns and intensities.



Figure 7: Haptic Sleeve [17]

2.2.6 Replica - The AI companion

Replica [18], advertised as the “AI companion who cares” is a chatbot based on artificial intelligence that allows users to connect and express themselves. It focuses on different aspects and can be used as a way of journaling, expression, and planning. Several user reviews show that it has helped with anxiety and stress, as well as providing an additional way to express oneself.

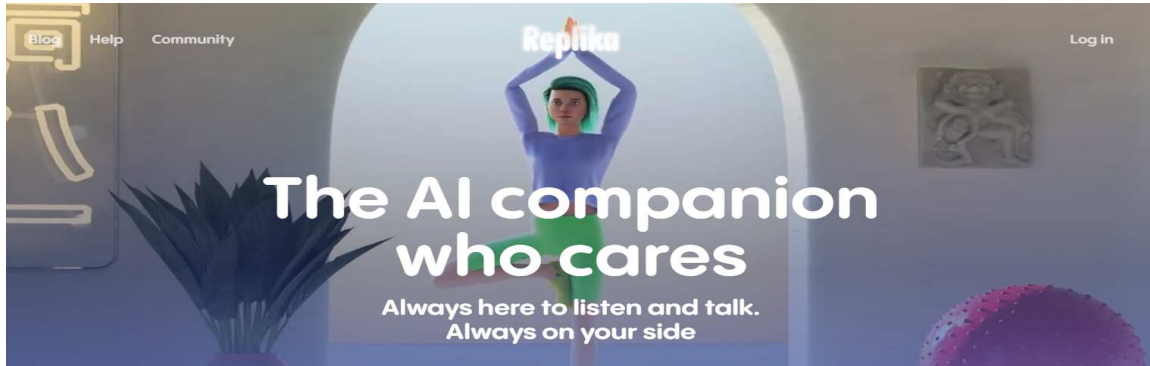


Figure 8: Replica - AI companion [18]

2.2.7 Animo: Expressive Biosignals through Smartwatch

F. Liu et al. [19] present a smartwatch app called Animo. This app utilises the biometric data gathered by a smartwatch and allows users to share it. Animo is exploring a new opportunity for “lightweight and mood-centric interactions”, by using “external biosignals” to convey “internal experiences.”



Figure 9: Smartwatch - Animo [19]

Chapter 3 – Methods and Techniques

For this project, the Creative Technology design process created by Mader et al [20] was the foundation, as well as the general approach for methodology. The interdisciplinary nature of Creative technology is also reflected in its design cycle, combining the "user-centred design approaches from Industrial Design and Interaction Design" with the classical engineering design principles involved in developing prototypes.

3.1 Creative Technology Design Process

The user-oriented creative technology design process consists of 4 phases, Ideation, Specification, Realisation and Evaluation. As seen in the model in figure 20, the design process is an iterative cycle, encouraging evaluation and adaptation of the individual phases at all times. In the following section each phase of the CreaTe design process will be discussed in relation to this project, as well as the specific methods and techniques used in each phase of this project.

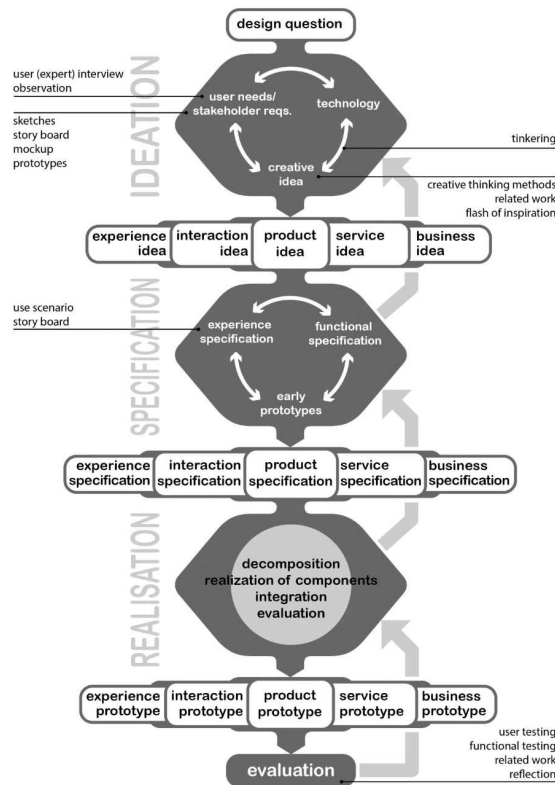


Figure 8: CreaTe Design Process [20]

3.2 Ideation

The process related to the ideation phase, as described in the CreaTe design process, is called “tinkering”. As seen in figure 20, it is an ongoing cycle of exploring creative ideas, identifying user and stakeholder needs and analysing existing work to gain further insights on the current technologies and applications. For this project, the ideation phase started very broad, starting with the concept of intimacy and extimacy, and working towards generating the specification criteria, through research, a literature review and a state-of-the-art analysis. The final stage of the ideation phase consisted of generating different ideas based on the brainstorm and analysis, and finally choosing the idea to move forward within the specification phase.

3.2.1 Brainstorm / Mindmap

Brainstorming is a useful tool to generate concepts and spark new inspiration for ideas. For this project the brainstorming was done using a mindmap. This mindmap served a big role in combining the previous research, literature review and state of the art, to specify the concept and start generating ideas. Whilst there were no detailed requirements for the brainstorm / mindmap, the main goal was to organise and get an overview of the existing research. This would aid in generating the ideas and concepts to choose for the specification phase,

3.3 Specification

The specification phase revolves around expanding the concept and “specifying” the design criteria and (non) functional requirements. It includes generating and discarding different ideas, prototypes and concepts. Due to the broad and theoretical scope of this project, the specification phase focused on finding the concrete design requirements, and diving deeper into the concept that was generated during the ideation phase of the design process.

3.3.1 Ethical Design Thinking

Ethical design thinking is a methodology that emphasises moral principles and ethical considerations during the design process. It serves as a problem-solving approach that emphasises creating solutions that are not only effective but also ethically sound. For this project, it played a big role in identifying the key ethical dilemmas and challenges. To do this, different ethical techniques were applied (specified in section 5), as well as a workshop conducted. The ethical principles and codes that resulted from this exploration were then turned into the (non) functional requirements

3.2.2 User Research

User research is the systematic study of the target user, understanding their needs by exploring their behaviours and motivations. Various methods, such as surveys, interviews, and usability testing, are used to explore these user requirements. For this project, user research was done through an online survey. The online survey consisted of two parts: 1. User research and 2. User testing (see section x). For the user research, the online survey focused on exploring musical and cultural background as well as the intensity and range of emotions felt by participants when listening to music. This data was collected using a combination of multiple-choice questions and open questions, which resulted in quantitative and qualitative data, respectively. Analysing the quantitative data was done using different statistics, while the qualitative data was evaluated using thematic analysis and coding.

3.4 Realisation

The realisation phase implements the research and insight from the specification phase to develop the chosen idea. The methods used during this phase often revolve around “realisation of the components, integration of the components and evaluation.” For this project the realisation phase consists of different disciplines of interface design, sound design, functional coding and prototype creation.

3.5 Evaluation

The evaluation phase, as the name states, revolves around evaluating the prototype and design (that resulted from the previous phases). During this stage the project is analysed, (user) tested and reflected on based on the design research and requirements. For this project the main evaluation comes from user testing and the design requirements specified earlier on. Reflecting on the outcomes will give a deeper insight on the strengths of the current prototype and design, as well as the points of improvement. With the limited time frame, and the different aspects of this project (interface, coding, emotion research, sound design) there are aspects of the design requirements that still need further exploring and testing. This will become evident in the evaluation and will be discussed further when considering future work for this project.

3.5.1 User Testing

User testing is the process of involving target users to test and evaluate a prototype, specific functions or features. There is a wide range of testing methods (surveys, interviews, observational testing) that can be combined with different stages and versions of a prototype focusing on different aspects (functional, content, accessibility, etc). For this project user testing was part of the online survey (mentioned in 3.2.2). The user testing was focused on evaluating the audio content, specifically the authenticity- one of the ethical principles and design requirements of the specification phase. The test consisted of audio prototypes and evaluated how well the intended emotion was evoked by the designed musical elements.

To accurately test this, and to minimise the bias, there were two main testing approaches: 1. Suggestive testing and 2. Non-Suggestive Testing. Suggestive Testing entailed that the participants were not informed of the emotion/mood the audio was designed for. To do this, the user listened to an audio (without knowing the emotion it was designed to evoke) and selected the main emotion they experienced while listening to the audio (see section x). For the suggestive testing, participants were told the intended emotion that the audio was designed for, and were asked to evaluate on a likert scale (1-5) how well they thought it matched.

Chapter 4 – Ideation

The following section documents the ideation phase as described in the CreaTe design process. For this project, the ideation phase was primarily focused on background research (literature review and state of the art), using it as a foundation for this phase to generate ideation concepts and criteria to develop in the specification phase (chapter 5). A big part of the ideation phase consisted of mindmapping, and laying out the existing research to find common trends within the literature concepts and technologies analysed.

4.1 Criteria (6 Ways) for Designing Extimate Technology

The background research on intimate and extimate technologies, as well as analysing different technologies (section x), resulted in criteria for various ways to design extimate technologies:

Ways to Design Extimate Technology:

- Integration of personal data
- Blurring the boundaries (between the inner world and outer world)
- (Self) Expression / Communication
- Humanization of Technology
- Seamless integration
- Reflect human nature

(descriptions of these criteria from the literature, see chapter 2.3)

4.2 Choosing (Self) Expression / Communication

Whilst there is some overlap between the criteria, they all provide a unique perspective and approach to designing intimate and extimate technology, gathered from researchers and projects with different views and definitions of extimate technology. Furthermore, whilst they were all viable approaches for designing extimate technologies, the goal was to move forward, focusing on one of them to have a more specific starting point. Brainstorming with these concepts (see figure 9) and analysing extimate technologies led to choosing the “(Self) Expression / Communication” Criteria.

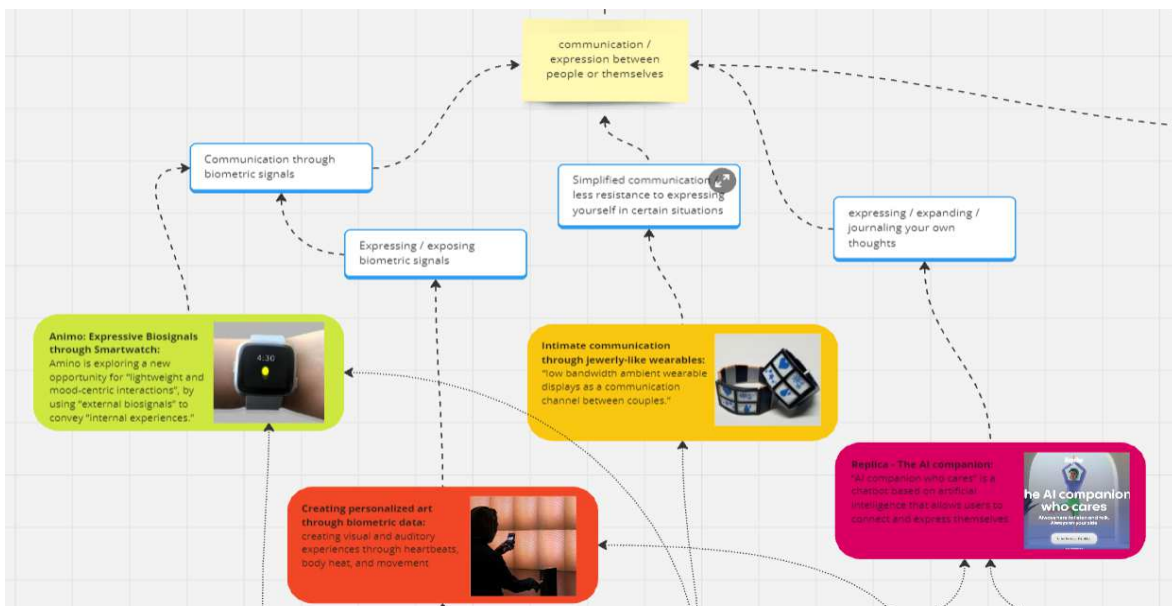


Figure 9: Mindmap - State of the Art

As seen on the mind map above, all the technologies serve to express and communicate ourselves. Whether that's allowing self-expression (like the AI companion and the art installation) or a form of expression between humans (such as the smartwatch and jewellery like wearable).

Furthermore, self-expression and communication are the criteria that correlate the most with the initial background research on the topic of intimacy and extimacy. With extimacy being defined (in section 2.2) as our inner thoughts, feelings, and experiences exteriorizing themselves, it supports the criterion that revolves around expressing ourselves (our inner thoughts, feelings, and experiences) and communicating / exteriorizing that inner world outwards.

4.3 Exploring Ideas and Concepts

Having identified the main criteria and approach for designing estimate technologies (in this project) laid the foundation for further brainstorming, research, and conceptualization. The first brainstorm to expand the scope of self expression/communication, was to consider the question: How does one self-express or communicate? What are the different mediums that we use to communicate?

1. Haptic feedback / physical feeling (touch, vibration, warmth, etc)
2. Biometric data (expressing based on heartbeats, bodyheat, movement, etc)
3. Simplified communication (instead of language using simplified means like logos, colours)
4. Text and language (communication through language and text)
5. Visual Communication (Conveying messages through images, graphs, charts, diagrams, and other visual aids)
6. Non-verbal Communication (Utilising gestures, facial expressions, body language, posture, and eye contact to communicate without words)
7. Audio Communication (Transmitting information through sound music, spoken words, including and other audio recordings)

This list provided different functions and mediums (found from analysing the existing technologies from section 2.2) that could be used and implemented when designing a technology made to (self) express and communicate. The technologies analysed during the state of the art also showed that many were designed for specific target groups.

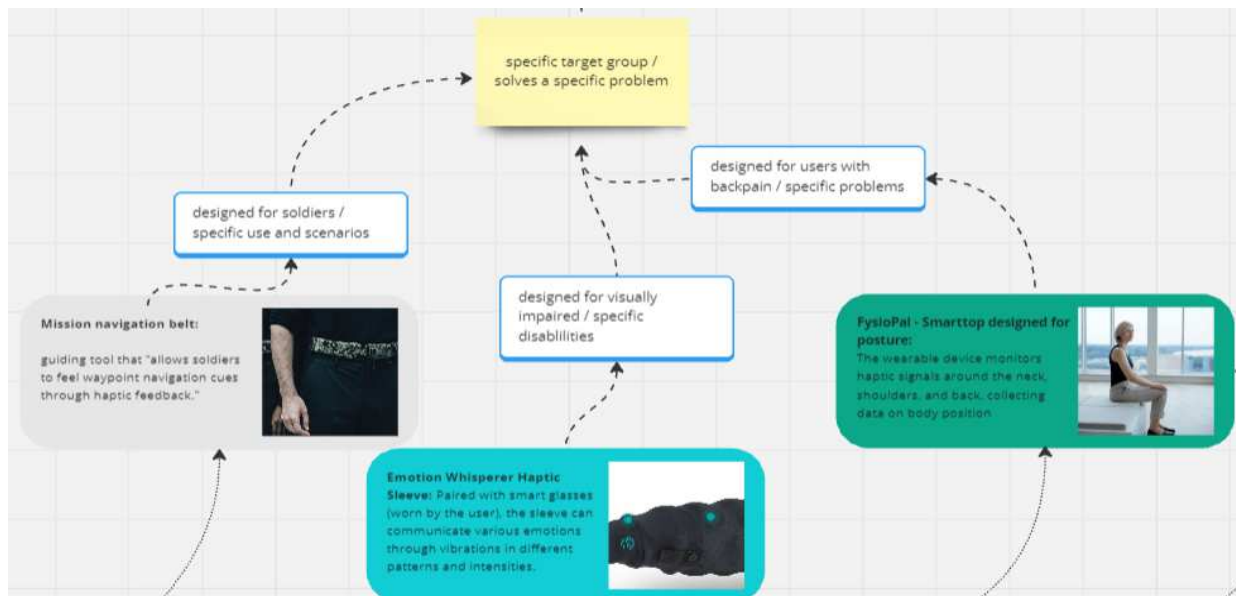


Figure 10: Mindmap - Specific Target Group

This led onto the exploration of which target groups might struggle to communicate / self express, or which scenarios could benefit from another means of communication and expression.

1. **Introverted Individuals:** People who are introverted may struggle with initiating conversations or speaking up in group settings.
2. **Highly Anxious Individuals:** Those with high levels of anxiety may find it challenging to express themselves clearly due to fear of judgment or criticism.
3. **Language Barriers:** People facing language barriers, such as non-native speakers or those with limited language proficiency, may encounter difficulties in expressing their thoughts effectively.
4. **Ambiguous Communication Channels:** In scenarios where communication channels are unclear or misinterpreted, such as through email or text, misunderstandings can arise.
5. **Cultural Differences:** Individuals from diverse cultural backgrounds may struggle to communicate effectively due to differences in communication styles, norms, and gestures.
6. **Unresolved Conflict:** Existing conflicts can create tension and inhibit open communication
7. **Too Much or Too Little Information:** Overloading with information or providing insufficient details can impede understanding
8. **Mismatched Communication Styles:** Differences in communication styles can lead to misinterpretations

4.4 Concept / Ideation Criteria


Using the concepts and inspiration from the research and brainstorm, the ideation criteria was created. This ideation criteria would serve as the new starting point to generate ideas. The criteria covers potential target groups or scenarios and includes different technologies that could serve as a starting point / inspiration for an idea.

Ideation Criteria:

- Design Extimate Technology with a focus on communicating or encouraging (self) expression
- Express / Communicate through different mediums (haptic feedback, visual / auditorial, biometric, etc)
- Designed for a target group or scenario (target groups who have trouble communicating, situations that require or could use different forms of (self) expression / communication)

4.5 Generating Concepts

Using the ideation criteria, new concept ideas were generated. At times the communication medium or technology served as a starting point to inspire a new idea. E.g. thinking of ways how haptic feedback can be implemented in a technology to communicate and/or encourage (self) expression. Other times a target group or specific scenario was used as a starting point. E.g. Which target groups have trouble communicating or expressing themselves? In which scenarios do people feel limited or restricted to express / communicate? One idea, that was generated using the “scenario thinking” approach, was in a classroom scenario where teachers ask if everyone understands the content. Struggling students might stay silent out of shame or embarrassment, not realising they are not alone. This specific scenario illustrates a situation where students might be hindered to communicate / self express themselves and where a technological solution could aid in lifting that barrier (further details on this idea in table 1).

Idea Nr.	Visual	Name	Description	Communication Medium	Target Group (or Scenario)
1.	 <p>Figure 11: Art installation [21]</p>	Art Installation (non-verbal expression)	Art installation that uses biometric input to visualise and express inner world	Visual and Audio Communication	Anybody but could be especially targeted for users with limited verbal abilities.






2.	 <p>Figure 12: Space Invader [22]</p>	Space Invader	Wearable(s) that detect the distance and gives gentle reminders to communicate personal space	Haptic Feedback (little vibrations from bracelet / wearable)	Users who have trouble with personal space (E.g. autistic or introverted)
3.	 <p>Figure 13: Classroom [23]</p>	Insightful Classroom	Technology that allows students to discreetly report how they are following along in the classroom. Prevents students from staying silent out of shame or embarrassment.	Simplified communication through buttons (either smileys or colours- red, yellow, green e.g.)	Classroom scenario / setting
4.	 <p>Figure 14: Touchlink [24]</p>	Touchlink Bracelet / Link	Simplified communication between friends or couples. Let the other know you are thinking of them by sending them an emoji to their bracelet.	Simplified communication through emojis.	Situations where you can't call your friend or significant other- on the train, in the rain, driving home.
5.	 <p>Figure 15: Meet Mate [25]</p>	Meet Mate App / Ring	Real Life dating app that allows users to overcome the barrier of talking to people in real life: If two users are close to each other who are looking to meet new people, the app or ring will take the first step to engage the interaction.	Communication through haptic feedback or visual cue on their phone.	Anybody who wants to meet more people in real life.
6.	 <p>Figure 16: EasyJam [26]</p>	EasyJam: Music For Everybody	Musical expression without needing any musical knowledge or skill by combining pre-made elements designed for certain moods and emotions.	Communication and expression through music and audio elements.	Anybody but specifically non musicians who don't already practise musical expression.

Table 1: Concept Ideas

4.6 Choosing Final Concept: EasyJam - Music for everybody

The final idea that was chosen was EasyJam - Music for everybody. Since each idea was generated using the ideation criteria, all of them were concepts of intimate technologies, designed by focusing on ways that technology can be implemented to (self) express and communicate. However Idea 6, EasyJam, had some fundamental aspects that made it the ideal intimate technology prototype to design for this project.

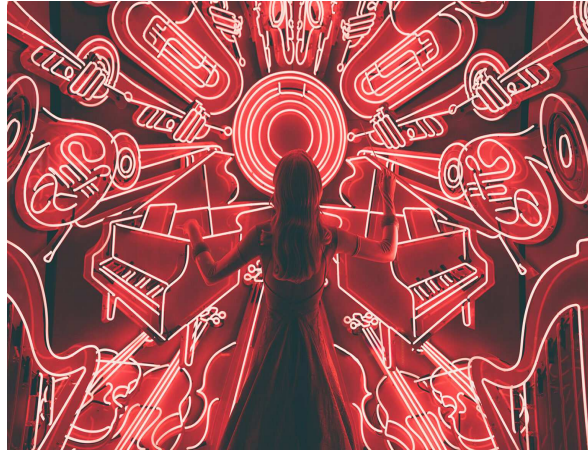


Figure 16: EasyJam [26]

Musical Expression: Through music, easy jam allows users to express a wide range of emotions. Not only can users express these emotions, but through music, they truly feel what they are expressing. This is a unique quality which not many other communication mediums (described in section 4.3) possess.

Accessibility: EasyJam allows individuals without any musical knowledge or skill to engage in musical expression, a practice millions of people enjoy and engage in. This aligns with the concept of intimate technologies by making the expression of one's inner world accessible to a broader audience.

Universal: Music is also known as the universal language because it's practised around all parts of the world. No matter the culture or language one speaks, music is a universal way to communicate and express oneself.

To summarise, EasyJam utilises one of the most powerful universal communication mediums to express our inner world, designed for non-musicians (everybody), a specific target group, overcoming the barriers of skill and knowledge that typically limit access to musical expression.

Chapter 5 – Specification (Part 1)

The Specification phase was split into two parts:

1. identifying principles and specifying design criteria.
2. further research needed to explore those criteria to be able to start realisation phase)

After selecting the final concept in the ideation phase, the specification process focuses on working out the details such as creating functional and non functional requirements. As described in the methodology (section x), this process used ethical design thinking to identify and expand on the key challenges and principles of this project. These served as a foundation for the (non) functional requirements which identified key areas for the user research.

5.1 Ethical Risk Sweeping

Ethical risk sweeping (part of the toolkit designed by the Markkula Center for Applied Ethics) is a method for identifying and mitigating potential ethical issues in engineering and design projects. For EasyJam, performing such an analysis early on in the design process can help establish parameters and criteria that will lead to (part of) the design specifications.

1. Privacy Risks

The first type of risks I will discuss are privacy risks. Since the installation revolves around feelings and moods and will possibly ask the user about their moods and feeling, it is important to consider what information will be saved and the risks involved.

Data Collection: The installation might collect simple data such as moods, feelings, and potentially capture the audio that the user creates.

Data Storage and Security: To eliminate any privacy risks, I will ensure that the data is securely stored and protected from unauthorised access. Furthermore, I am planning on not saving the data and deleting after every experience, unless the user requests to save it and receive the data (such as the audio they made and the input they gave about their moods and feelings).

Anonymity: Furthermore, users will participate anonymously, meaning that any data that is saved will not be linked to any name or other identifiable data.

2. Emotional and Psychological Wellbeing

The next (and the most important) risk is related to emotional and psychological impact and wellbeing. While it is the aim of the installation to evoke emotions, as well as have an emotional impact on the user, it does come with a risk of negatively affecting mental wellbeing.

Risk related to Emotional Well-being: In order to minimise the risk of affecting mental wellbeing, I must first Assess potential emotional risks for users expressing their emotions through music, including negative experiences.

Disclaimers and Support Systems: Having identified the possible risks and target groups that might encounter such discomfort, I must implement precautions to prevent these from happening. Firstly, I will ensure there are disclaimers and warnings before starting the experience that will inform users who might be at risk of experiencing negative impacts from such an installation. Also, if possible, I will implement mechanisms to support users who may experience distress during their interaction, such as volume to control the loudness, a stop button to end the experience, and further functions that will be beneficial (based on the literature).

3. Accessibility

As mentioned in the ethical code, accessibility is one of the main criteria for installation. Accessibility refers more to the functionality and interface, inclusion refers to the musical choices for designing the musical elements;

Accessibility for all: To make the design accessible for all (with functional hearing), it must not require any musical skills related to producing music. By being a music producer, it involves the risk of potentially designing with a bias for what the user is able to complete. Maybe the design works for me, but not for the user.

User testing: To minimise the risk and ensure accessibility for all, detailed user testing regarding the sounds, function and interface must be completed throughout the design process, to get consistent feedback on the functionality for the non-musician user.

4. Inclusion (Risk of Exclusion based on musical / cultural background)

Inclusion, in the scope of the EasyJam Prototype, refers to considering the risk of exclusion based on musical and cultural background;

Cultural Sensitivity: When designing music, it is important to remember different cultures and musical backgrounds. Being ignorant of the fact that users will relate to different types of music imposes the risk of exclusion. For example, if the installation was designed using Western music, a user from Asia might not relate to the music to the same degree. Although they can perfectly use the installation (functionality and accessibility wise), they have been excluded in their music background and might not have the same experience.

User Testing: To minimise the risk of exclusion, the design process should include various users to test the audio, as well as aim to design audio that is universal, ensuring the platform respects and includes diverse musical traditions.

5. Intellectual Property

User-Created Content: Clarify who owns the rights to the music created within the installation and how it can be used.

Fair Use: Ensure that intellectual property rights and fair use policies for musical content are respected.

Note: Since the audio will be designed from scratch and using authorised sources, there should be no issues with intellectual property. However, this still needs to be considered and ensured throughout the process.

5.2 Applied Ethics - Fleddermans Line Drawing

Due to the nature of the ethical codes having an inverse relationship (as one improves the other declines), I will use one of Fleddermand's Ch.4 Ethical Design Problem-Solving Techniques [27]: Line Drawing.

Line drawing is a technique used to analyse hypothetical solutions, placing them on a line between the "positive paradigm," the ideal morally accepted outcome, and the "negative paradigm," representing the worst / non-morally accepted outcome. For my design, one of the major ethical concerns is the balance between authenticity and accessibility as well as emotional impact and wellbeing. Therefore I will use these criterias to form my best-case scenario (positive paradigm) and my worst (negative paradigm).

Positive Paradigm: EasyJam is accessible to everybody who is able to listen to music. The experience allows musicians as well as non musicians to authentically express themselves and their emotions. The experience is impactful and moves the user but never affects their emotional well-being in a negative way.

Negative Paradigm: EasyJam is not accessible to everybody. It requires skills/knowledge that non-musicians do not have. The experience allows a form of self-expression; however, it does not feel authentic and genuine to the user. The user does not relate to the perceived emotions they are trying to express in the installation and the experience has a negative impact on their emotional wellbeing.

Extra note: Due to the inverse relation of these criteria such as accessibility vs authenticity, as well as emotional wellbeing vs impact, the negative paradigm seems unrealistic / does not reflect the "give and take" nature of the criteria; The user does not relate to the perceived emotions, but the installation has a negative impact on their emotional wellbeing? A more realistic scenario would be that the user relates strongly to the perceived emotions; however, this has an impact on their emotional well-being. However, for this hypothetical negative paradigm I decided to keep it like this to find possible negative scenarios where this could potentially happen; The user does not relate to the perceived emotions and music has a negative impact on their emotional well-being (maybe not from the emotions that they didn't connect with but from the distress they experienced from not connecting with the music and emotions?).

5.2.1 Defining the range of Negative and Positive Paradigms

Next, I will describe and conceptualise the different outcomes, numbering them to later distribute them over the line diagram. To try to come up with all the possible outcomes I will go from (what I think) negative to positive, however in the later analysis their positioning could still change on the line diagram.

0 (Negative Paradigm): EasyJam is **not accessible** to everybody. It requires skills/knowledge that non-musicians do not have. The experience allows a form of self-expression; however, it **does not feel authentic and genuine** to the user. The user **does not relate** to the perceived emotions they are trying to express in the installation and the **experience has a negative impact** on their emotional wellbeing.

1: EasyJam is **not accessible** to everybody. It requires skills/knowledge that non-musicians do not have. The experience allows a form of self-expression; however, it **does not feel authentic and genuine** to the user. The user **does not relate** to the perceived emotions they are trying to express in the installation but the experience **does not have any negative impact** on their emotional wellbeing.

2: EasyJam is **not accessible** to everybody. It requires skills/knowledge that non-musicians do not have. The experience allows a form of self-expression and **feels authentic and genuine** to the user. The user **does relate** to the perceived emotions they are trying to express in the installation however the experience has a **negative impact on their emotional wellbeing** due to the lack of transparency to the user.

3: EasyJam is **not accessible** to everybody. It requires skills/knowledge that non-musicians do not have. The experience allows a form of self-expression and **feels authentic and genuine** to the user. The user **does relate** to the perceived emotions they are trying to express in the installation and the experience **does not have any negative impact on their emotional wellbeing** because the right precautions were taken to inform the users about the activity and warn any users with potential risks of experiencing discomfort from such an installation.

4: EasyJam **is accessible** to everybody who is able to listen to music. The experience allows a form of self-expression; however, it **does not feel authentic and genuine** to the user. The user **does not relate** to the perceived emotions they are trying to express in the installation and the **experience has a negative impact** on their emotional wellbeing due to experiencing discomfort and not being informed of the potential risks involved with the experience.

5: EasyJam **is accessible** to everybody who is able to listen to music. The experience allows a form of self-expression; however, it **does not feel authentic and genuine** to the user. The user **does not relate** to

the perceived emotions they are trying to express in the installation but the experience **does not have any negative impact** on their emotional wellbeing. They were informed about the activity and any users who were at risk of experiencing discomfort stopped participating.

6: EasyJam is **accessible** to everybody who is able to listen to music. The experience allows a form of self-expression and **feels authentic and genuine** to the user. The user **does relate** to the perceived emotions they are trying to express in the installation however the experience has a **negative impact on their emotional wellbeing** due to the lack of transparency to the user.

7 (positive paradigm): EasyJam is **accessible** to everybody who is able to listen to music. The experience allows a form of self-expression and **feels authentic and genuine** to the user. The user **does relate** to the perceived emotions they are trying to express in the installation however the experience does **not have any negative impact on their emotional wellbeing** because the right precautions were taken to inform the users about the activity and warning any users with potential risks of experiencing discomfort from such an installation.

5.2.2 Placing the Paradigms on a Ethical Line

Before analysing these scenarios and placing them on the scale, it is important to note the weight of certain criteria. The most important criterion (which will have more weight in deciding the ranking of a scenario) is emotional well-being. Under no circumstances should the emotional well-being of a user be sacrificed for a design. The next criterion that plays a large role is accessibility. This is one of the main criteria, and other than safety criteria (such as well-being) will have more weight regarding the ranking.

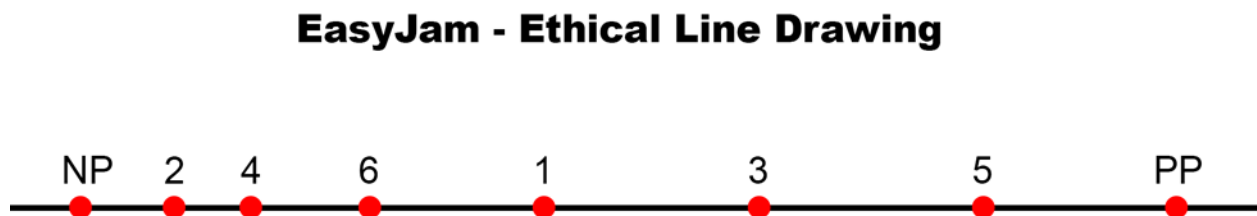


Figure 17: Ethical Line Drawing

5.3 Main Ethical Dilemmas

Authenticity vs Accessibility

The main and most important ethical dilemma of this installation and project, lies in the balance between authenticity and accessibility. As mentioned, the main goal of this project is to allow non-musicians (as well as musicians) to express their moods and feelings using music. In order to achieve this for users who have little to no musical experience (in producing or playing an instrument), the musical elements are pre-recorded and designed. This means every musical element has been made to ensure it is synced (in time) and key (in the right harmonic context). These criteria are crucial to the design to ensure every user has an enjoyable/musical experience. It does come with the risk of compromising the authenticity of their creative expression.

Can the combination of pre-recorded tracks truly and authentically express how a user feels?

Will users resonate with the moods and feelings that the tracks are designed to evoke?

Emotional Impact vs Emotional Wellbeing

EasyJam is designed to connect with users emotionally whilst fostering a deeper and personal connection with the music created. Users should be able to express a wide range of emotions effectively and use musical elements to enhance these moods and feelings. In theory, this installation should allow users to go on an emotional rollercoaster, immersing and feeling their emotions through the music they're creating. While designing for these criteria, the goal is to make the installation and experience as impactful and moving as possible. Pushing this boundary, however, also introduces a new dilemma and concern: the user's emotional well-being.

Can the installation be so impactful that it causes concerns to the user's emotional wellbeing?

How can we design an impactful and breathtaking music installation while ensuring the user has full control over their emotional experience?

5.3 Moral / Ethics Code

Having applied different ethical design techniques to identify and explore the challenges and aspects of this project, the ethical code was defined. This code highlights the most relevant details that resulted from the previous ethical exploration and serves as the foundation to create the design requirements (in section x).

Accessibility: One of the main design ethics is making the installation easy to use and accessible to both musicians and non-musicians. The goal is to share the joy and self-expression that comes with music production with non-musicians / producers. Accessibility ensures that everyone can engage with and benefit from the installation, regardless of their musical background and prior knowledge and skills in music.

Authenticity: Ensuring that users can express a wide range of emotions and feelings is a crucial design aspect of this project. Trying to achieve authentic and genuine emotional expression using a combination of pre-recorded musical elements is one of the main design challenges (since the goal is to allow users to express themselves through music, not to simply create music). This code of ethics is the main driving force that motivates and encourages thorough user testing on different emotions and moods and on how different musical elements match up to those experiences.

Inclusivity: An important ethics for this design is Inclusivity. Whilst it has an overlapping criteria with accessibility- allowing everybody to be able to use and access the design- This strand focuses on the different experiences that people might have due to different music tastes and cultures. F.e., If the installation is designed using Western music, a user with a different culture might not resonate with the music, making it harder to express themselves and have a meaningful experience. Even though the installation is perfectly accessible and usable (f.e. interface, language), it might not be relatable. This also overlaps with the Authenticity ethics. If the pre-recorded tracks are not authentic to the users then it will be hard to truly achieve self expression and emotional impact- and if its only authentic for a specific group or music taste, then we have failed to include all users in having a meaningful experience. It should also be noted that inclusivity, in this context, is not focused on physical restrictions or limitations that users might have- the most obvious one being deaf or having trouble hearing (when designing an audio installation). Whilst this should not be neglected, creating an audio installation designed to include users who have trouble hearing audio is a complex project, revolving around different technologies and research that is outside of the scope (and time frame) of this project.

Emotional Wellbeing: Being clear and open about how the installation works and its potential emotional effects is crucial for preventing any emotional distress. It also prevents any other personal / emotional risks (that only the user knows) that are difficult to predict. Users should understand how the installation functions and what to expect from their interactions. When designing this means having comes in the form of information that is provided about the emotional goals and mechanisms of the installation to ensure informed consent.

Respect for Autonomy: Respect for Autonomy describes the goal to make the user feel empowered to navigate their emotional journeys without feeling manipulated. This means respecting the users' ability to make their own choices and control their interaction with the installation. This principle overlaps with others such as authenticity, emotional-wellbeing and transparency but focuses on giving the user full control to personalise their experience and control the intensity of emotional engagement. Specifically, that the music is a result of their emotion and not the other way around. It is easy to fall into the design of guiding the user on an experience rather than having them create the experience. In this installation, asking the user how they feel before they start or engaging them in their emotions could help them be more present and conscious of the emotional direction they are going for.

5.4 Specific Requirements

Poel [7] describes the process of turning values into one or more specific design requirements by translating a “more general value” into one or more general norms and turning each norm into more specific design requirements. Having established the ethical code, the following section focuses on using each moral principle (ethical code) to develop the (non) functional requirements to realise this design.

General Value: Accessibility

General Norms (for Accessibility)	Design Requirement (for Accessibility)
Ensure the system is user-friendly for non-musicians	Design a library of pre-recorded tracks that are in sync, in harmony and matched to each other
Provide intuitive interface and controls	User Interface (UI): Design a simple, intuitive UI with clear instructions and visual aids to guide users through the experience.
Guarantee inclusivity for users with diverse abilities and backgrounds	Ensure that all musical elements (and combinations) work together

General Value: Authenticity

General Norms (for Authenticity)	Design Requirement (for Authenticity)
Allow users to express a wide range of emotions	Develop a library of library of pre-recorded musical elements that cover a broad spectrum of emotions
Ensure emotional expression are genuine and true to the users feelings	Conduct user testing to ensure musical elements match with the emotional description

General Value: Inclusivity

General Norms (for Inclusivity)	Design Requirement (for Inclusivity)
Cater to diverse musical tastes and cultural backgrounds	Research and design musical elements from a wide range of cultures and genres.

General Value: Emotional Wellbeing

General Norms (for Emotional Wellbeing)	Design Requirement (for Emotional Wellbeing)
Clearly communicate (and be transparent) on what the user expects	Provide comprehensive instructions on how the installation works and what the installation entails.
Avoid causing emotional distress to users.	Include specific information about the potential emotional effects of the installation to warn about potential risks to emotional wellbeing

General Value: Respect for Autonomy

General Norms (for Respect for Autonomy)	Design Requirement (for Respect for Autonomy)
Empower users to make their own choices about their emotional expression	Engage users in reflecting on their emotional state to help them consciously choose their emotional direction.

Table 2: Design Requirements

Chapter 5 – Specification (Part 2)

Having identified key design requirements (in part 1 of the specifications), the following section (part 2) focuses on the research and preparations needed to execute the design requirements in the next design phase (realisation). This will consist of literature research and user research, to gain further insights on the design requirements and the user group.

5.5 Research Study: Moods in Music

Based on the research requirements (from section 5.4), specifically “*Develop a library of pre-recorded musical elements that cover a broad spectrum of emotions*”, the following research aims to identify the main emotions that are felt when listening to music. Identifying the main emotions that humans experience when listening to music will be required when designing the audio for specific emotions later on.

5.5.1 UC Berkeley Study (Emotions in Music)

Researchers at UC Berkeley conducted a study [28] with over 2,500 participants from both the United States and China to explore their emotional reactions to various songs across a wide range of genres, such as rock, folk, jazz, classical, marching band, experimental, and heavy metal. While this study focuses on connecting emotions to full songs rather than specific elements, it serves as a good starting point for identifying the main moods and emotions that people feel when listening to music. Furthermore, the study focused on participants from the United States and from China meaning they include two different cultures, which could be broadly categorised as Western culture (american) and eastern culture (china). Whilst it certainly does not give the full picture, it does align with the ethical code of inclusivity (to some extent) by including multiple cultures.

5.5.2 Study Findings (13 Emotions)

The study [28] reports “13 distinct types of experiences that people across 2 different cultures report in listening to music of different kinds”. The main mood/emotions participants reported were amusement, joy, eroticism, beauty, relaxation, sadness, dreaminess, triumph, anxiety, scariness, annoyance, defiance, feeling pumped up. These findings were used later on as a foundation to design further user research on emotions experienced while listening to music.

5.5.2 Study Findings (Interactive Audio Map)

After testing all the audios and gathering the results the researchers (as well as other contributors) ended up making an interactive map (see figure 18), plotting all the audios and their reported emotions.

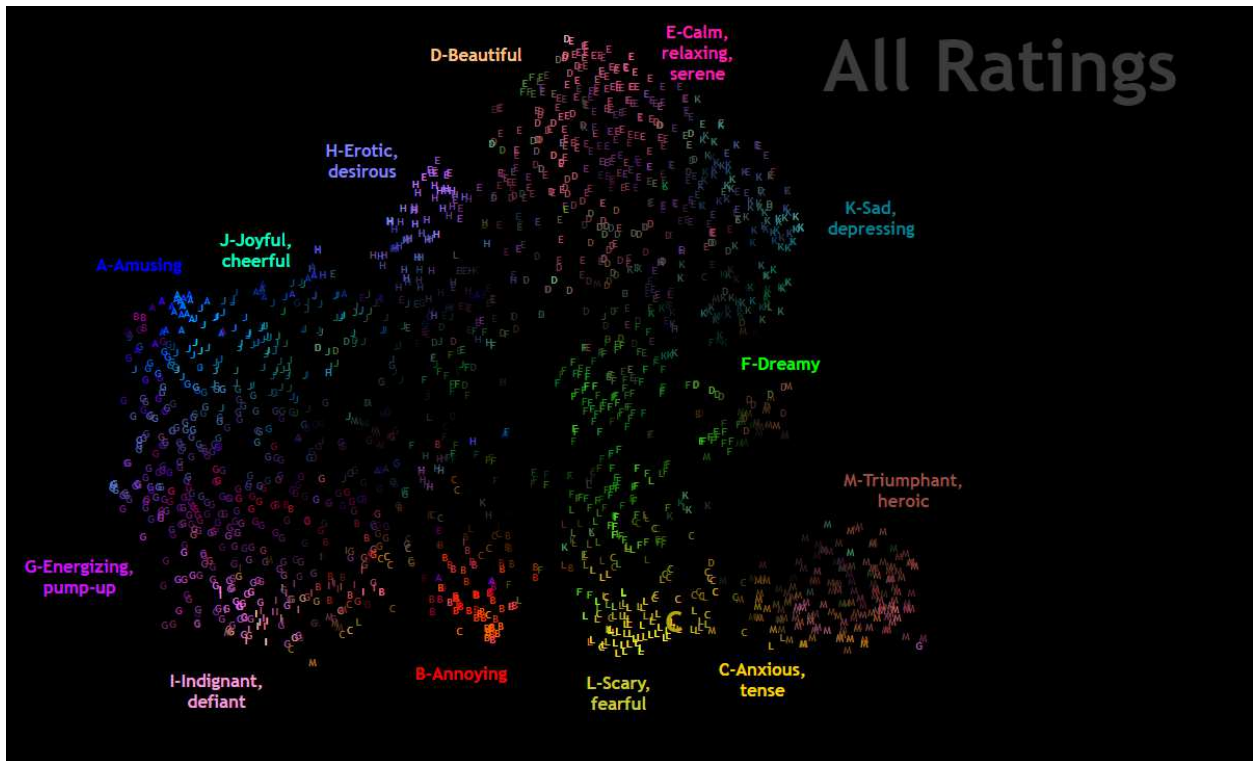


Figure 18: Interactive Audio Map from Study [29]

The interactive map served as a useful reference (in the realisation phase) when designing the audio content for specific emotions.

5.7 User Research (Online Survey)

An online survey, consisting of two parts, was used to conduct more user research as well as test audio prototypes of the design. The following section documents and reflects on the user research (part one) which revolves around the emotions felt by participants, their musical and cultural background, as well as their overall relation to music.

5.7.1 Setup (Online Survey)

The target group of the research was anybody above the age of 16+. Demographics include age, gender and a distinction between musicians and “nonmusicians”. The separation between musicians and “nonmusicians” was intended to explore any differences that might hinder users (specifically non musicians) from practising musical expression. Further open questions revolved around the relation between cultural / musical background and musical preference. This explores the impact of cultural background on user experience, supporting the ethical code of inclusivity by aiming to understand and design for diverse musical tastes and cultural backgrounds.

5.7.2 Survey Questions

1. The survey questions started with simple demographics including **age** and **gender**. Whilst there was no planned analysis these metrics were useful to track in case of any biases and possible trends.
2. The following set of questions were general questions designed to explore the participants' relation to music. These included how often participants listened to music, how strongly they felt emotions when listening to music and whether they played any musical instruments (distinction between musicians and “nonmusicians”). These questions were designed to make a distinction between participants who already engage in musical expression and whether this would have an effect on how strongly they felt emotions and feelings from listening to music. *Do non musicians connect to music the same way as musicians? Does the target group of non musicians*
3. The last set of questions (from the user research; online survey part 1) was focused on exploring the relation between cultural background and music preference, as well as exploring the main emotions participants perceived when listening to music. This consisted of open questions such

as: *How does your cultural background influence your music preference? (Did you grow up with any traditional music? Did your family play certain music when you were young?)*

And exploring how participants felt emotions when listening to music consisted of an open question: *What feelings / moods do you usually feel when listening to music? (describe moods, feelings and/or emotions)* followed by a multiple choice question of selecting the main emotions they felt when listening to music, inspired by the main reported emotions from the study in section x

5.7.2 Procedure / Recruiting Process

Although the preferred target group was non-musicians (as they don't already engage in musical expression), the installation is designed to be used by anybody, ranging from all ages aged 16-75. This age group excludes young teens and elderly people beyond 75 as they might have more trouble engaging with the interface and understanding the controls. This meant that for the recruiting process, anybody in that age range was recruited, whether they engaged in musical expression already or not.

To recruit the participants the survey was sent out via email, whatsapp and social media. This ensured that a lot of people were able to part take in a short amount of time. Participants were also asked to share the survey if they wanted to, to recruit more participants for the study. Personally sending out the survey resulted in some age bias which will be discussed further in section 7.1.3.

Before part-taking in the survey, participants were asked to read and fill out a consent form which can be seen in appendix A. Lastly, the second part of the online survey, which consisted of user testing the audio prototype of the design will be discussed further in section x.

5.7 Outcome User Research

Out of the 50 participants, 49 continued the survey after reading and providing consent to part take. From those 49 participants, 17 were female, 31 were male and one preferred not to say. The age distribution can be seen in figure 19. Out of the people who did not engage in musical expression like playing an instrument or singing (non-musicians) 77% of them reported the desire or thought to play or create music.

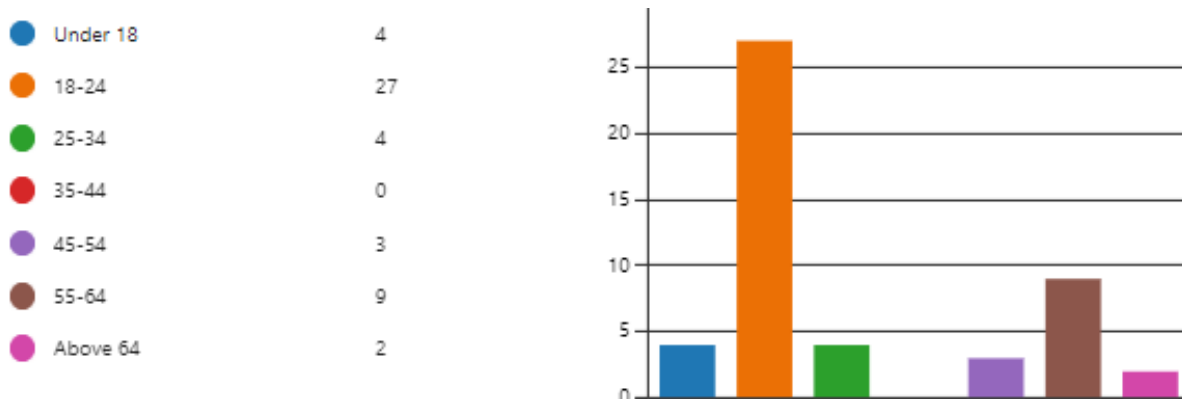


Figure 19: User Research - Demographic

Out of all participants, 65% reported to feel emotions from music strongly when listening to it, with 25% reporting to feel emotions slightly and 12% reporting strongly (as seen in figure 20). Furthermore when comparing these statistics between musicians and “non-musicians” we see that 23% of “non-musicians” reported to feel music moderately, 69% strongly and 8% extremely. Similarly, 22% of musicians reported to feel music moderately, 61% strongly and 17% extremely.

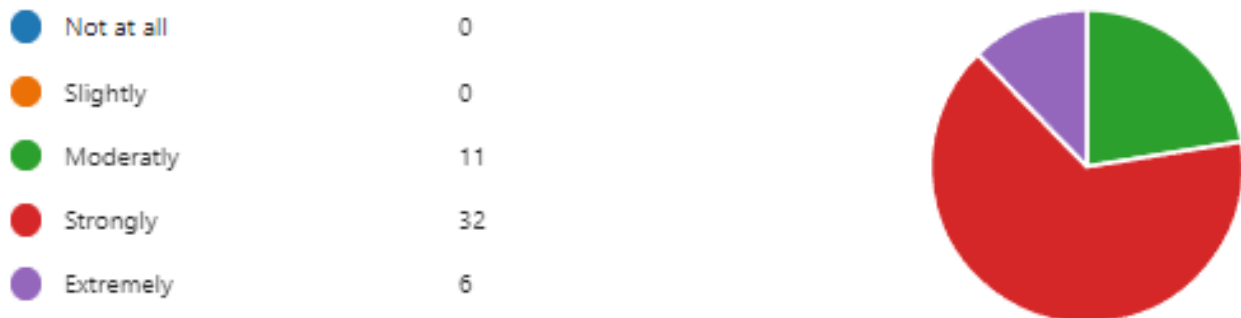


Figure 20: User Research - Intensity of felt emotions from music

From the open question regarding the influence of culture and musical background on current music taste there was a common theme that was coded from all the Responses. Overall users reported to have been influenced from their past, either from cultural / traditional music, or from music tastes that their parents had, but also specifically noted that their own music taste has developed and deviated since then; “parents influence, but also developed my own”, “Grew up listening to the music my dad listened to. But now we have different music tastes”, “Typical National Radio, other than that my Music tastes evolved over the years and were mainly influenced by mainstream online media.”

When exploring the music preference, there was a wide range of genres that participants reported listening to (see figure 21).

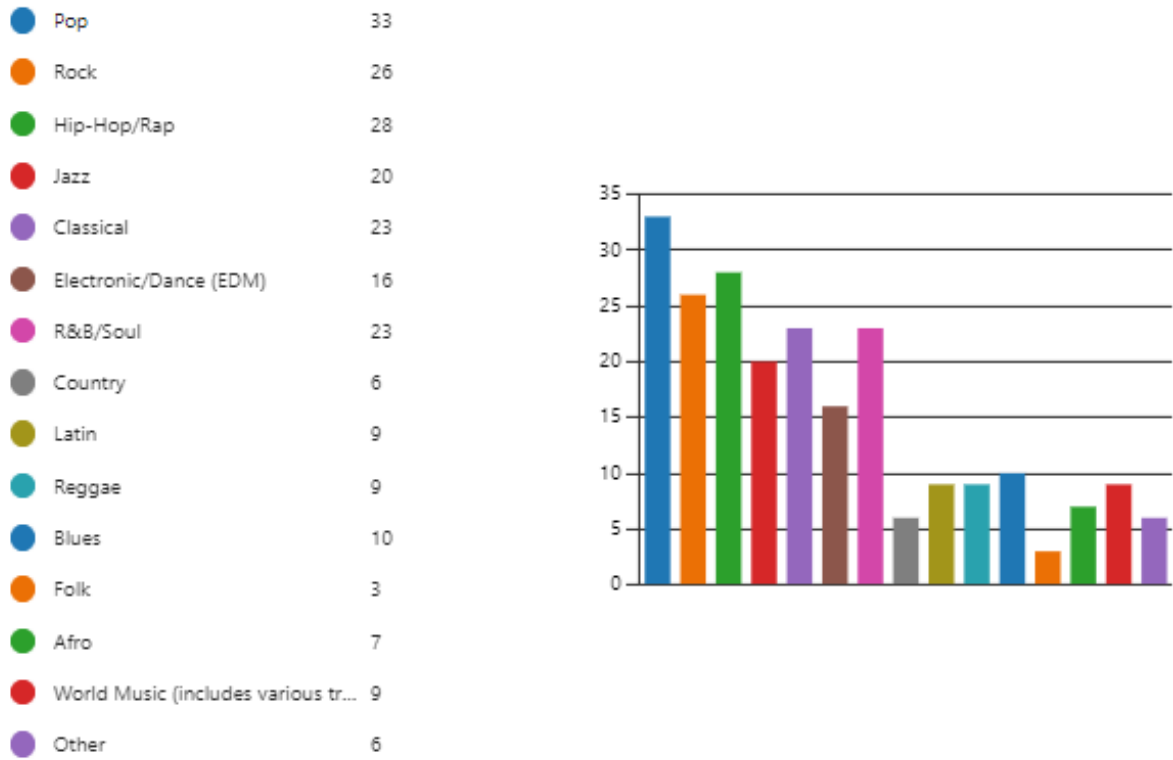


Figure 21: User Research - Genres

When asking users to describe the main emotions they felt from listening to music (in an open question), many reported common emotions such as happiness, sadness, relaxation, and melancholy. Others report that the emotion is a result of the music they put on and want to feel; “I pick my music depending on my mood, so when I’m feeling down or sad I like to listen to music that represents my emotions”.

When asking users to select their main emotions they felt based on a range of emotions (see figure 22), the most common reported emotions were joy, relaxation, sadness, dreaminess, feeling pumped up and excitement.

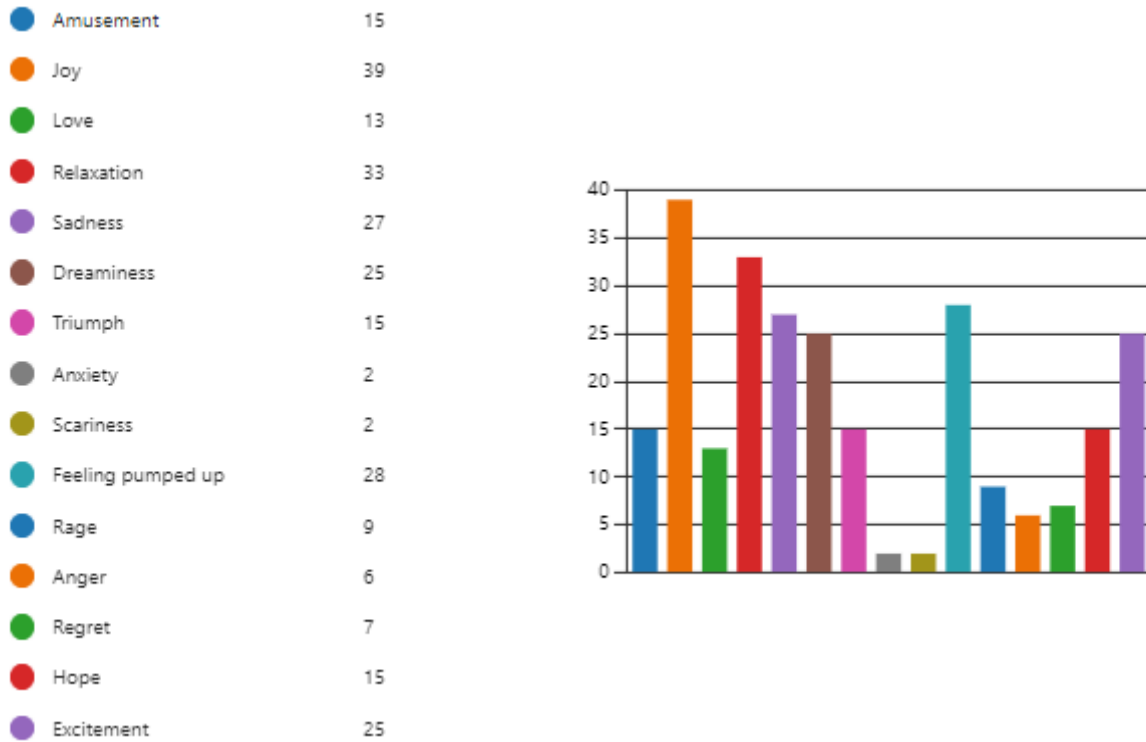


Figure 22: User Research - Main Emotions

5.7.2 Discussion of User Research

The user research was a great way to empathise with the user more, specifically looking for trends between musicians and nonmusicians. The foundation of musical expression is the feeling that is felt through music, which is also a major part of this project. Without being able to connect and feel music, this installation would not be very effective when using music to express and connect deeper with our feelings. It was to be expected that users who engage in musical expression (play an instrument), also strongly feel moods and emotions when listening to music, however the “non-musicians” actually reported to feel the music just as much. Whilst a few more musicians reported to “extremely” feel emotions and moods from music, overall there was an equal distribution between musicians and non-musicians, with the majority (65% of all) reporting to “strongly” feel moods and emotions from music.

Another supporting trend for this project was that out of the “non-musicians”, which were people who did not play any musical instruments, 77% reported the desire to play or create music. This argument supports the demand or interest in such a project, showing that the “non-musicians” (the ideal target group) have the desire in engaging with music rather than not being interested in creating music at all.

The open questions exploring the relation between cultural background and music preference showed that whilst almost all participants that reported remembering music from their childhood most of them stated that their music taste ended up in a different direction, mainly due to outside influence such as media and the internet. This trend could also be linked to age bias that occurred, with 55% of the participants being aged from 18-24 (further discussed in section x). Considering this generation grew up with a lot of outside influence, mainly from the internet, it is understandable that their music taste has developed outside of their culture and family environment. When exploring the music preference of participants the top three genres were Pop, Hip Hop and Rock, although all the listed genres were chosen to show the diversity in music taste.

Chapter 6 – Realisation

Having established the specific requirements as well as the research required to realise this project, the next section focuses on the execution process of working on the different elements needed to bring the (EasyJam) experience together. As mentioned in the methodology (section x) the realisation consisted of the sound design, interface design and coding.

6.1 Designing the Sound

The following section describes the process of designing the sound for specific emotions. This section documents the tools and processes that were used.

6.1.1 FL Studio (Fruity Loops)

Fruity Loops, also known as FL Studio, is a digital audio workstation (DAW) used to design and produce sounds. A DAW is a software application used for recording, editing and producing audio files. Within the DAW there are several third party applications that can be installed and used to generate sounds or to edit sounds. These are called plugins, f.e. A grand piano, compressor (mixing tool) or string orchestra.

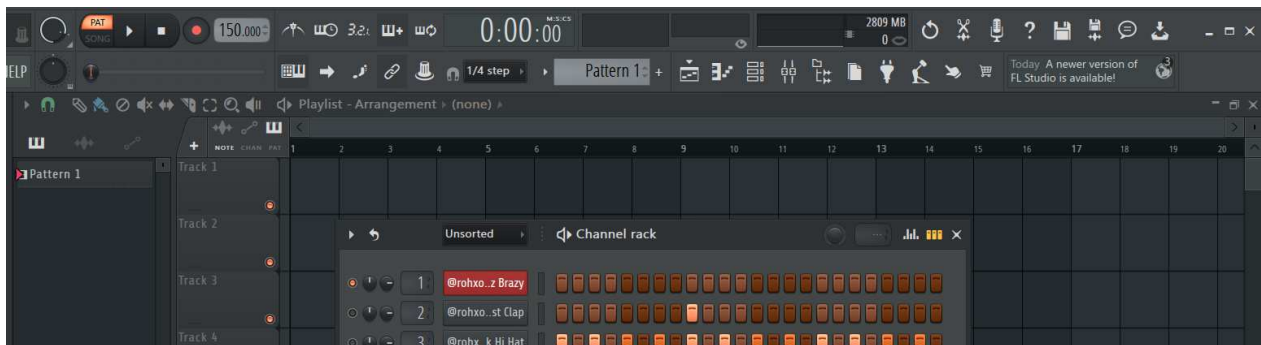


Figure 23: FL Studio - Overview

6.1.1 Plugins

For this project many of the sounds were generated using various plugins. As mentioned, plugins are (third party) applications within the DAW and open up endless possibilities to generate sounds, whether electronic pads, acoustic pianos or any other sounds one can think of. One plugin that was used for the piano sounds in this project was by Spectrasonics called Keyscape. Plugins such as Keyscape have

various presets of different pianos, as well as customizable settings to tweak the sound that is generated (see figure 24).



Figure 24: FL Studio - Piano Plugin

6.1.1 Midi Input

If audio is not recorded through a microphone or a line cable (used for guitars), sound can be produced using the plugins (e.g. piano). Input is then generated by midi (electrical input turned into notes) and by clicking in any additional notes and chords. See figure 24 showing an example of midi input (the “x axis” represents the notes that are being played (orange lines) and the “y axis” represents the time presented in musical bars)



Figure 25: FL Studio - Midi Notes

6.2 Designing for Specific Emotions

When designing for specific emotions, the applications and tools described in section 6.1 were consistently used to generate and edit the different sounds, however each emotion required a different approach in the type of sounds, the music theory applied and the details that aided in evoking specific emotions. The interactive map (described in section x) also served as a good reference and inspiration point when designing for a specific emotion. The following describes the sound design and research for each emotion in more detail.

6.2.1 Emotion: Joy / Happiness

General music theory describes minor and major chords as being sad and happy. Whilst it is arguable whether music theory can explain which emotions are evoked from different sounds, there are certain concepts that play a factor in shaping the general direction of a sound. From the interactive map, the references for songs that were reported to evoke joy and happiness, consisted of different instruments but were usually up tempo, bouncy and rhythmic songs. The songs often had acoustic elements like crowds and joyful cheers.

Based on the interactive map and the music theory, Designing sounds to evoke joy and happiness started with using a major chord progression, uptempo rhythms and adding subtle elements of acoustic crowds, that would be the final detail to steer the sound into a joyful direction. One of the sounds of the audio library (designed for joy / happiness) can be heard here [Joy / Happiness](#).

6.2.2 Emotion: Emotional / Sad

A lot of the sounds that were reported to be sad in the interactive map, consisted of slow and soft pianos, as well as subtle layers such as a violin or a vocal. When designing the sad audio, a soft and slow (minor) piano progression was used, layer with an emotional vocal. To add the final touch, a subtle rain texture was layered under the sound, as humans often associate rain with a sad / depressing state. One of the sounds of the audio library (designed for emotional / sad) can be heard here [Emotional / Sad](#).

6.2.3 Emotion: Scary / Dark

A lot of scary and dark music heavily relies on tension within the notes. When two notes close together are played at the same time, they create tension, causing an uneasy feeling. This is often used in horror sounds, or in warning sounds. Reference songs from the interactive map (that were reported to evoke a scary feeling) often used low sounds with a lot of tension, including background elements of scary breathing, screams or heartbeats.

When designing the scary / dark sounds, the tension and sound selection were the main factors that contributed to evoke this emotion. On top of that, sounds like evil voices, bells and violins were used to trigger this feeling, as they trigger common themes from horror movies that humans recognize. One of the sounds of the audio library (designed for scary / dark) can be heard here [Scary / Dark](#).

6.2.4 Emotion: Relaxing / Dreamy

Designing relaxing / dreamy sounds has a similar approach to happy / joyful sounds, but aims to slow things down more, creating a slow harmonic track. Similar to happy tracks, the relaxing sounds use a major scale but differ in their speed. There should be little to no tension between notes, creating beautiful harmonies that are soothing to listen to.

Various tracks that were reported to be dreamy (from the interactive map), used different instruments but had a slow tempo in common. They also had a full but empty sound, meaning the chords played throughout the whole song, but the chord changes were slow and would ring out before moving on to the next chord. When designing the audio, the slow tempo and harmonic nature was applied using a lofi piano. On top of that, subtle nature noises were added due to the relaxing effect of nature. One of the sounds of the audio library (designed for relaxing / dreamy) can be heard here [Relaxing / Dreamy](#).

6.2.5 Emotion: Triumph / Heroic

Designing to evoke a triumph / heroic feeling was heavily influenced by sound selection and what humans associate with this feeling. From movies and history, a lot of people associate horns, strings and footsteps with mediaeval battlefields. When listening through the interactive audio map, a lot of audio that was reported to be heroic / triumphant consisted of horns and strings. The sounds usually consisted of harmonic tones but also had some levels of tension in the composition, making it harder to find the right balance.

When designing the triumphant / heroic sounds, samples of heroic voices and horns were used as a starting point. To find these, a sample library was used to go through sounds until something triggered the right feeling. To layer that sound, horns were used to further solidify the triumph / heroic feeling. One of the sounds of the audio library (designed for relaxing / dreamy) can be heard here [Triumph / Heroic](#).

6.2.6 Emotion: Love / Romance

Love / Romance was another emotion that was harder to design for due to its resemblance with dreaminess, sadness and happiness. The music that was reported to evoke a feeling of love and romance (from the interactive map) often used minor chord progression but with more harmonic elements to make them sound less sad. This is often seen in R&B, a music genre that often describes love. The sound selection often consisted of guitar and saxophones, which transmit a lot of feeling and can be played in a smooth way.

When designing the sounds to evoke love / romance, a lot of ambient guitars were used. Also chord progressions from the R&B genre were used as these have the right balance between tensions and harmony. To add subtle details, ambient voices and breathing sounds were added, in an attempt to steer the sound from a more dreamy emotion into a more sensual direction towards love / romance. One of the sounds of the audio library (designed for relaxing / dreamy) can be heard here [Love / Romance](#).

6.1 Designing the Interface

The following section documents the process of designing the interface of the EasyJam experience. The interface is designed to allow the user to navigate and combine the different sounds that were designed in the previous section.

6.1.1 Interface Concept

From the specifications, the design criteria was to “Design a simple, intuitive UI with clear instructions and visual aids to guide users through the experience.” Considering the installation should be accessible and usable by anybody, the information should be understandable by users with no musical experience / knowledge.

The initial concept design (seen in figure 26) shows the menu in the bottom half of the screen, and an audio visualisation in the top half, displaying the audio elements that are currently being played.



Figure 26: Interface Concept

6.1.2 Interface Design

Adobe XD was used to start the interface's realisation. Adobe XD allows for visual design that can later be converted to HTML code for further modification and application use. Within adobe xd, the interface can be designed to allow the user to click through different emotions and their corresponding musical elements, allowing the user to switch between melody elements (such as piano, strings, etc) and drum elements (such as percussion, kicks, etc). Figure 27 shows the navigation process of clicking different elements and moving on to the next set of options.

Melody (Start) → Emotion → Specific musical elements (piano, synth, vocal) → Back to start

Drums (Start) → Type of Drums → Specific Drum elements (percussion, bass, kick) → Back to start

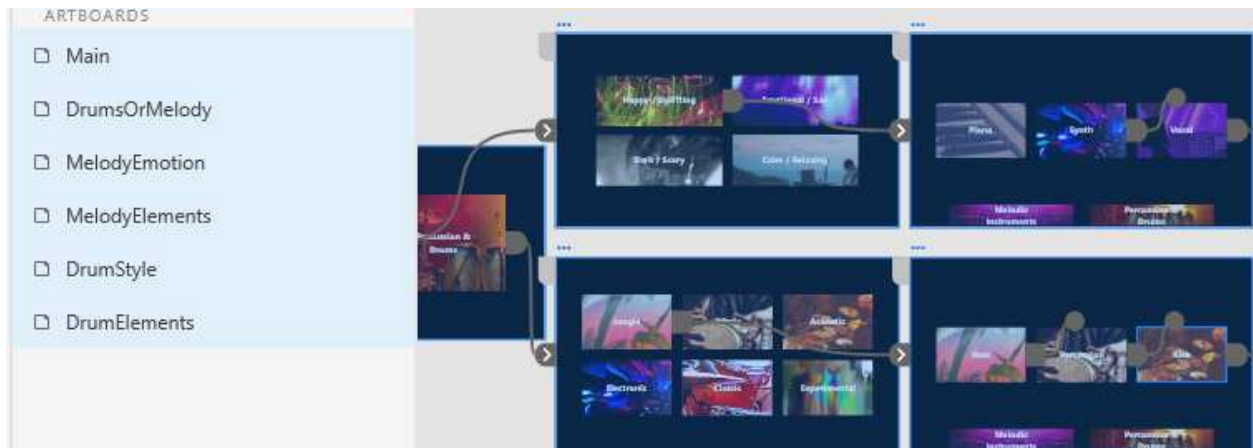


Figure 27: Adobe Xd - Interface Menu

6.3 Coding the functional design

Having designed the interface in Adobe XD, the next step was to add the functionality, like playing the audio, looping the audio and turning different elements on and off. Exporting the interface design (from adobe xd) to html provided the working space to add the functional code. To do this visual studio code was used. The following sections will explain the main functional code and how it was implemented to achieve the desired functionality.

6.1.2 Embed Audio Files and Functions

The first step to working with the designed audio files in the design was to embed them into the html page (see figure 28). To do this, the audio files were defined with an ID (so they can be used in later functions) and routed to the source (so the file knows where to find the file data).

```
<audio id="happyAudio" src="Documents\GP\HTML/happy-audio.mp3"></audio>  
<audio id="sadAudio" src="Documents\GP\HTML/sad-audio.mp3"></audio>  
<audio id="loveAudio" src="Documents\GP\HTML/love-audio.mp3"></audio>
```

Figure 28: Code - Embed Audio Files

6.1.2 JavaScript Functions

To add the functionality, a javascript file was created called audioFunctions.js. This file contained the following functions:

Interval Setting: To make sure the audio is in sync, looped and played every 8 bars, an interval had to be created. This interval was based on the speed of the audio elements which was 120bpm. Adding this interval allows the regulation and timing of adding new audio elements, making sure they start when a new interval starts.

```
let interval = 8 * 60 / 120; // For a 120 BPM and 4/4 time signature
```

Figure 29: Code - Interval

Audio playing status tracking: The audioPlaying object keeps track of if specific audioID (audio tracks) are currently playing or not.

```
27 let audioPlaying = {
28   happyAudio: false,
29   sadAudio: false,
30   loveAudio: false
```

Figure 30: Code - Status Tracking

Scheduling audio playback: Using the interval as a mechanism to track the time, the scheduling audio function ensures the audio is scheduled and organised to start in sync (every 8 bars) with the other musical elements. Upon clicking the audio element button, the scheduleAudio(audioID) function runs and organises the selected track to start the next 8 bars.

```
<button onclick="scheduleAudio('happyAudio')">Play Happy Audio</button>
<button onclick="scheduleAudio('sadAudio')">Play Sad Audio</button>
<button onclick="scheduleAudio('loveAudio')">Play Love Audio</button>
```

Figure 31: Code - Selecting AudioID

The scheduleAudio function tracks the current time and calculates the next start time using the interval.

```
function scheduleAudio(audioId) {
  let now = audioContext.currentTime;
  let nextStartTime = Math.ceil(now / interval) * interval;
```

Figure 32: Code - Schedule Audio Function

When an audio element is clicked (which can be done by the user to either start or stop an audio element), the schedule function runs and starts by checking if the audio is playing or not. If the audio is playing, it sets a time out to end the audio after 8 bars (see figure 33).

```
if (audioPlaying[audioId]) {
  // If audio is playing, stop audio
  audioElements[audioId].pause();
  audioPlaying[audioId] = false;
```

Figure 33: Code - If Audio is playing

If the audio is not playing (code: else) it starts looping the audio when the interval time is at 0, which ensures the audio is looping every 8 bars (see figure 34).

```
    } else {
      // Start audio
      audioElements[audioId].currentTime = 0;
      audioElements[audioId].play();
      audioPlaying[audioId] = true;

      // Loop audio
      audioElements[audioId].addEventListener('ended', function() {
        this.currentTime = 0;
        this.play();
      });
    }

    // Schedule to stop after 8 bars
    setTimeout(() => {
      if (audioPlaying[audioId]) {
        audioElements[audioId].pause();
        audioPlaying[audioId] = false;
      }
    }, (nextStartTime + interval - now) * 1000);
```

Figure 34: Code - Play / Loop Audio

6.3 Video Prototype (Concept Prototype)

Since the functional prototype was still missing visual design elements, a video prototype was created, combining the audio elements, interface design and functions to communicate the current state of the design.

This prototype can be viewed here [Concept Prototype.mp4](#)

Chapter 7 – Evaluation

The evaluation phase of this project reflects on the outcomes of the audio prototype that was designed in the realisation phase. It also evaluates the other elements of the prototype based on the design requirements, reflection on the execution and details of the realisation phase.

7.1 User Test Evaluation

The user evaluation was conducted in the second part of the online survey therefore the recruitment and procedure will not be described again (see section x for this). The following section will go over the testing approach and evaluation outcome. In total, 15 audio elements of the final prototype were tested.

7.1.1 Suggestive vs. Non-Suggestive (User Testing)

The user test evaluation consists of two distinct parts aimed at evaluating the emotional response of the audio prototype, consisting of the audio elements of the installation. Each sound was designed for a specific emotion, and this phase assesses whether the sound evokes the intended emotion. Successful evaluation of a sound element (by the majority of participants) indicates that the audio is a good representation of the feeling / emotion.

Non-Suggestive Testing: The first part involves non-suggestive testing to avoid influencing participant responses. Participants listen to a sound, without knowing the intended emotion it was designed for, and independently assign an emotion (from a set of multiple choice options) based on their experience.

Suggestive Testing: The second part implements suggestive testing, where participants are informed of the specific emotion associated with each audio element. They are then asked to rate the audio on a likert scale from 1 to 5 to evaluate how well it aligns with the indicated emotion. After rating the sound, users also had the option to reflect with any comments and report any other emotions they experienced (open question). Although this approach may introduce bias by informing users of the intended emotion, it more accurately reflects the nature of the installation, as the final setup will require users to select the emotion they wish to express.

7.1.2 Non-Suggestive Testing Outcome

For the non-suggestive testing, 10 audios were tested with the following results (red highlight indicate the emotion the sound was designed)



Figure 35: Suggestive testing - Overview

From the non-suggestive testing, all 10 intended emotions were experienced by the majority of participants per test, with the lowest performing test having a 53.0% majority and the highest 93.9% Majority. The audios are ranked from best to worst in the table 3, showing the second and third highest emotions that were also reported per sound.

Ranking	Intended Emotion (Test Nr.)	Main Reported Emotion (% of participants)	Secondary Reported Emotion (%)	Tertiary Reported Emotion (%)
1.	Happy / Amusement (Test 6)	Happy / Amusement (93.3%)	Love / Romance (2.0%)	Relaxing / Dreamy (2.0 %)
2.	Scary / Dark (Test 9)	Scary / Dark (89.8%)	Anger / Rage (10.2%)	/
3.	Triumph / Heroic (Test 3)	Triumph / Heroic (77.6%)	Happy / Amusement (6.1%)	Love / Romance (6.1%)
4.	Happy / Amusement (Test 2)	Happy / Amusement (71.4%)	Triumph / Heroic (20.4%)	Relaxing / Dreamy (6.1%)
5.	Sad / Emotional (Test 8)	Sad / Emotional (71.4%)	Relaxing / Dreamy (22.4 %)	Love / Romance (4.1%)
6.	Relaxing / Dreamy (Test 9)	Relaxing / Dreamy (65.3 %)	Love / Romance (18.4%)	Sad / Emotional (10.2%)
7.	Relaxing / Dreamy (Test 4)	Relaxing / Dreamy (65.3 %)	Sad / Emotional (24.5%)	Love / Romance (8.2%)
8.	Sad / Emotional (Test 5)	Sad / Emotional (63.3%)	Relaxing / Dreamy (22.4 %)	Scary / Dark (8.2%)
9.	Scary / Dark (Test 1)	Scary / Dark (59.2%)	Triumph / Heroic (14.3%)	Sad / Emotional (12.3%)
10.	Love / Romance (Test 7)	Love / Romance (53.0%)	Relaxing / Dreamy (42.9 %)	Sad / Emotional (2.0%)

Table 3: Suggestive testing - Ranking Audio Tests

7.1.3 Suggestive Testing Outcome

For the suggestive testing, 5 audios were tested with the following results:

Test 1: Audio for “Hope”

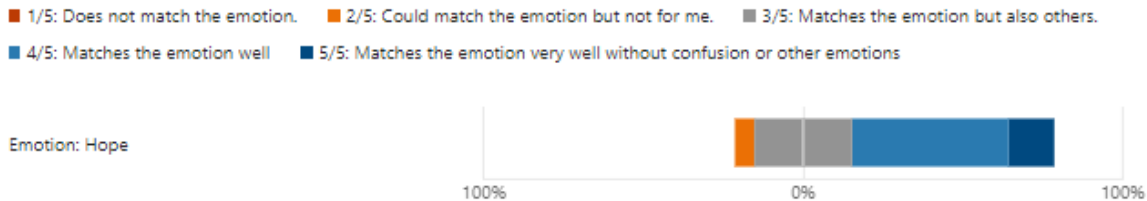


Figure 36: Non-suggestive testing - Test 1

14 respondents used the optional open question to describe other feelings / emotions they felt from this audio. Two participants mentioned “Nostalgia”, whilst the other ones consisted of a wide range of non recurring emotions such as “joy”, “relaxing”, “feeling motivated”, “excitement”.

Test 2: Audio for “Triumph”

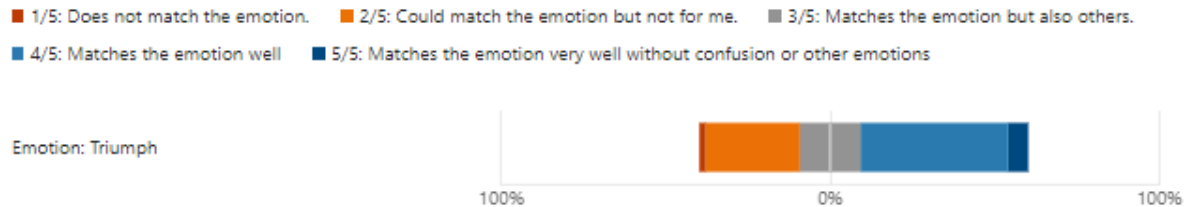


Figure 37: Non-suggestive testing - Test 2

For test 2, 27 participants provided further input using the open question. 4 users reported experiencing a “sad” and emotional feeling from the audio, whilst 3 other users reported similar feelings of “strength”, “feeling of power” and “courage”. The other ones were non recurring emotions some of them being “Hope”, “Dark” and “Anticipation”.

Test 3: Audio for “Sad / Emotional”

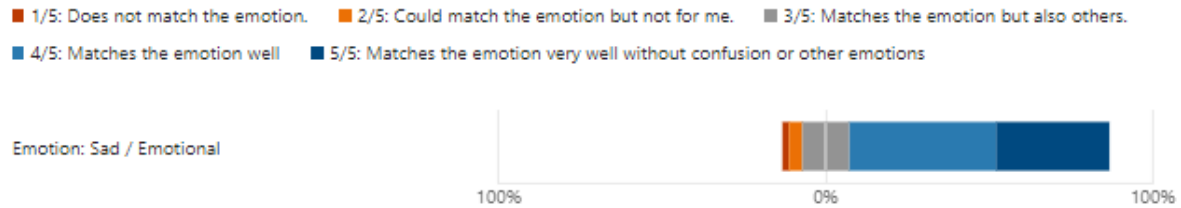


Figure 38: Non-suggestive testing - Test 3

Due to its positive outcome, the third test only had 11 participants that reported other feelings and experiences from the audio. Four users reported experiencing “relaxation”, one of them stating “pure relaxation” and a fifth participant describing a “calm” feeling. Two other users described feeling “hope” and the rest of the responses varied such as “romance” and “mysterious”.

Test 4: Audio for “Love”

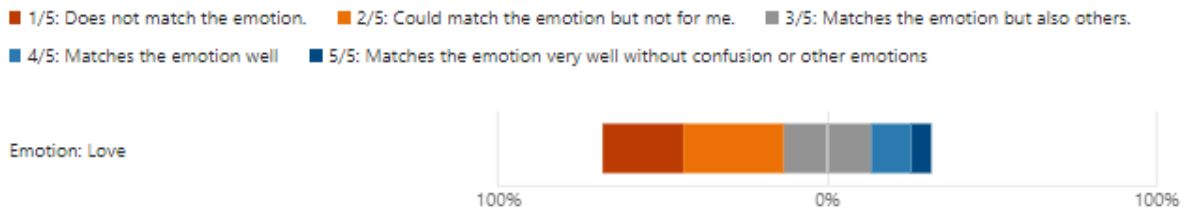


Figure 39: Non-suggestive testing - Test 4

Due to the low rating of the sound, there were more participants that gave input on other emotions they experienced. In total there were 26 users that reported other emotions. The most common one, reported by six users, was “joy” and “happiness”. Other common themes were “chaos” and “confusion”, reported by three users, as well as, “dreamy” which was reported by three users.

Test 5: Audio for “Evil / Scary”

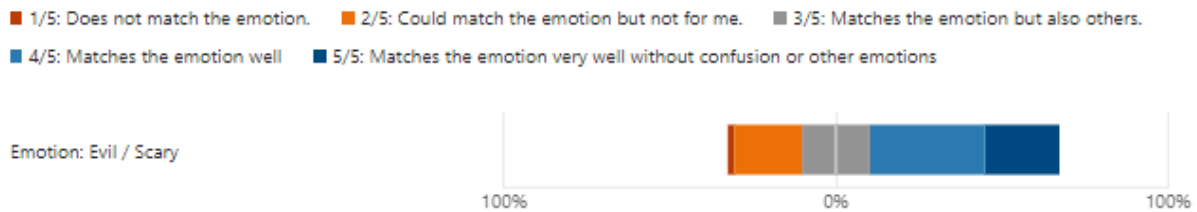


Figure 40: Non-suggestive testing - Test 5

Test 5, had 16 responses of participants reporting different experiences. Two participants reported a “bad ass” feeling, whilst another two described feelings of “anger” and “revenge”. Two more participants reported a “heroic” feeling.

7.1.3 Discussion of User Testing Outcome

The non-suggestive testing showed positive results that all the intended emotions were experienced by the majority of participants (at least 50%). Studies on emotion recognition [30] often regard 70% as a strong indication of effective communication of the intended emotion. Aiming for a majority agreement of 70% is a strong consensus among participants whilst still considering the subjective nature of music and emotions. Based on this benchmark, 5 out of the 10 audio elements qualify for the final prototype.

Analysing participants' reported secondary emotions revealed trends in related moods / emotions, indicating that secondary and tertiary emotions were often similar. The two different audio tests for “Relaxing / Dreamy” each time had “Love / Romance” and “Sad / Emotional” reported as their secondary and tertiary emotion. Vice versa, the audio test for “Love / Romance” had “Relaxing / Dreamy” and “Sad / Emotional” reported as secondary and tertiary emotion respectively. This was also seen in the suggestive testing, where three users reported to experience a “Dreamy” emotion when the audio was designed for “Love / Romance” When comparing the findings from UC Berkeley (mentioned in section 5.5.1), the same trend can be seen with the same emotions.

This subjective similarity between “Love / Romance” and “Relaxing / Dreamy” was also clearly observed in audio test 7, where the audio designed for “Love / Romance” evoked a “Relaxing / Dreamy” feeling in almost half the participants (see figure 41).

21. Select the main mood/emotion you hear and feel from this audio. (test 7)

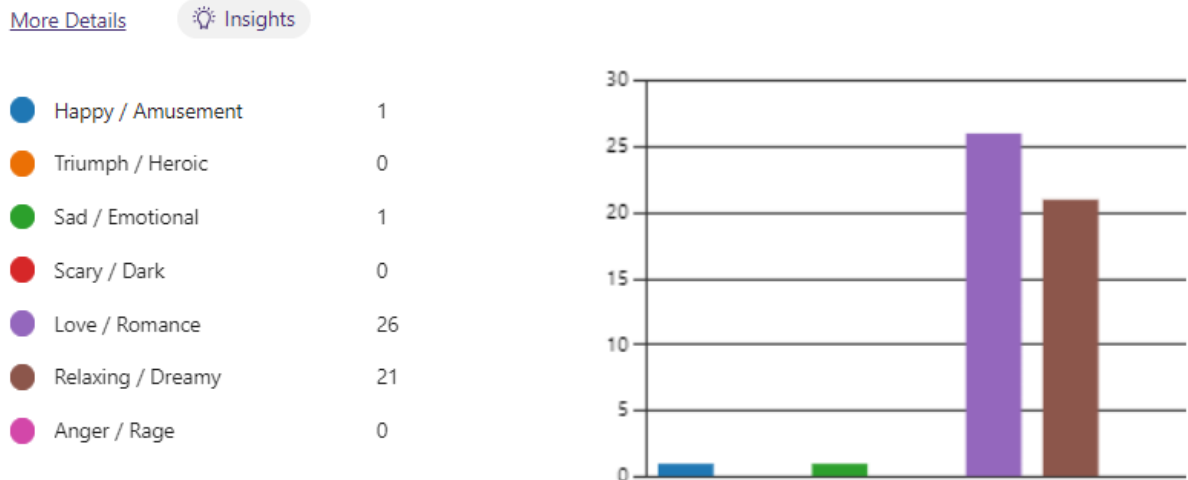


Figure 41: Suggestive Testing - Test 7

This trend also suggests that it might be harder to evoke certain emotions due to their subjective similarity with other emotions. Whilst the execution of the sound design highly impacts the “performance” of the sound, it should be noted that both audios from “Happy / Amusement” ranked first and fourth, whilst both audios from “Dreamyness / Amusement” ranked 6th and 7th from the non-suggestive testing.

Furthermore, both audios designed for “Love / Romance” performed the worst in each type of test. In the non-suggestive testing, the audio for “Love / Romance” barely reached the majority, scoring 53.0%.

Similarly the suggestive testing revealed that 55% of participants felt the “Love / Romance” audio did not match the intended emotion, marking it as the worst-rated sound in the suggestive testing.

Chapter 8 – Discussion & Future Work

The background research illustrated the rather new concept of intimate and extimate technologies. After defining the concept and ways to design intimate and extimate technologies, further research on existing technologies that embody this concept was done, however the term was often not used in these projects. Whilst the term accurately describes the ongoing shift in the relation between humans and technology, finding research and projects that used the terms intimate / extimate technologies was rare. This could reflect the current technological focus, which still approaches projects through the lens of technological advancement rather than human interaction.

Further research and evaluating steered the project in to the direction of (self) expression and communication which, defined as one of the ways to design extimate technologies, also reflected the initial definition of extimacy- to express and communicate one's inner world. Whilst this led to various different ideas, based on different mediums to express or communicate, the project's focus was finally set to musical expression- specifically musical expression for non musicians. Musical expression for anybody soon revealed the conflict between authenticity and accessibility. Designing the experience to be accessible for all, also meant using pre-made musical elements, which in return made it harder to achieve authentic expression. This concept motivated further user research and testing based on emotional expression exploring the subjective nature of perceived emotions in music.

User Research highlighted non-musicians' desire to create music as well as their emotional connection to music, supporting the foundation for this project. Media and internet appeared to reduce the link between cultural background and musical preference, though this might only apply to those who grew up with the internet, as indicated by an unintended age bias in the user research (discussed further in section x). The main emotions experienced, reported by participants, were in line with a previous multicultural study conducted by scientists at UC Berkeley. The combination of this research served as the foundation to design audio, using a combination of music theory and sound selection, to evoke specific emotions.

User testing in the form of an online survey was used to evaluate the audio prototype, evaluating whether the intended emotions were perceived by the user. User feedback was crucial when working with the subjective nature of music, however clear trends were seen in the perceived emotions. Every intended emotion during the audio tests was perceived by at least 50% of the participants, with the highest being 93.9% and the lowest 53.0%. With the defined majority agreement of 70%, representing the minimum benchmark to indicate a clear emotional signal, 5 out of the 10 tested audios qualify to be implemented in the final prototype.

Whilst the main goal of the user evaluation was to test the audio prototype, it also revealed significant trends that impact the design of specific emotions. The analysis showed relations between certain emotions, due to reported secondary and tertiary emotions often being similar. The subjective overlap between “Love / Romance” and “Relaxing / Dreamy” was evident in multiple audio tests, indicating that certain emotions might be harder to evoke due to their similarity with other emotions. Furthermore, both audio tests for “Love / Romance” performed the worst in each type of testing. Similarly, both audios for “Relaxing / Dreamy” did not reach the 70% majority benchmark. This could be due to their similar nature, being more likely to evoke more than just the intended emotion, and should be considered when setting a majority benchmark, as some designed emotions might not be able to reach it. Exploring this concept further would require a larger sample size, and quality control, as the audio design for each test introduced uncontrolled factors. (further discussed in section 7.1.3).

7.1.3 Limitations

During the process of the project and evaluation, certain limitations became apparent, which, with extra consideration, provide insight when reflecting on the project and future work.

Firstly, the project's goal was to design an experience that is accessible and enjoyable for everybody. This aimed to include all ages and cultures, being specified in the ethical code “inclusivity”. This was also reflected in the user research and testing, aiming to include users from all age groups (16+). Due to the recruitment method of relying on personal contacts and social media, there ended up being an unintentional age bias with 55% of users falling within the 18-24 age group. Furthermore, while this study referenced a multicultural study (eastern culture and western culture), further attempts to diversify the research, either through recruitment and/or demographic questions about culture were missing. Even with the multi-cultural study, general cultures like latin american culture, african culture and middle eastern culture were not included in the research for perceived emotions.

Due to the nature of the audio based user testing, a selection of 15 audio files had to be made. This was to ensure the user testing would not exceed 20-25 minutes, since there was no other incentive or reward for participants. This limited the user evaluation to only test a fraction of the designed audio, but most of all it also limited the breadth of the evaluation. A larger (more time intensive) evaluation, containing more audio tests would have resulted in stronger conclusions on some of the trends that were noticed, due to more data being available. Furthermore, analysing trends in the “performance” of different emotions could not take into account the level of execution per sound, meaning the accuracy of designing for that emotion. Whilst this was not the main aim of the user evaluation, it should be noted that the

design of the audio could have had a significant influence on its “performance” rather than the nature of the emotion. For the resources and time frame of this project, ensuring that one individual designed all the audio elements (which was the case) was the best attempt to create an equal testing environment.

Finally, one limitation that should be mentioned for the overall process of this project was combining the user research and user testing in one survey. This was done to include as many participants in both the user research and the user testing but came with the limitation that the user research could not be included when designing the first audio prototypes that were tested in the same survey. Whilst this seemed counter-intuitive at first, it made sense considering the time frame, and considering the ongoing design cycle, all insights gathered could be used to re-evaluate and enrich the previous phases.

7.1.3 Future Work

The theoretical and practical scope of this project was heavily focused on estimate technologies, (self) expression and communication, and how authentic expression could be achieved through pre-made musical elements. This resulted in a focus on the user research (in relation to emotion), designing elements to evoke certain emotions, and evaluating these elements in the user testing. Future work for this project consists of further development and testing of the interface design as well as the functional coding. The current design prototypes and audio prototypes are ahead of the functional prototype. Currently the functional prototype has the main looping, playing and stopping function implemented, yet the visual design (seen in the video prototype) has not been implemented. Future work such as designing and user testing different interfaces (using different layouts and coding different functions) could be the next step to realise the final prototype.

Further theoretical research on the trends seen from the user evaluation would also enrich this project, but also the literature on music and evoked emotion, that has not been explored. Whilst it is often argued that the nature of music and emotion is “too subjective”, clear trends in the limited data of this user evaluation, provided interesting assumptions that could be explored and tested.

Chapter 9 – Conclusion

How can technology be designed to embody the concept of intimacy and extimacy?

Intimacy refers to the “inner world” of thoughts, feelings, and experiences. Extimacy simply refers to the exteriorizing and expressing that “inner world” (SQ1). Based on current literature, extimate technologies can be designed in different ways such as integrating personal data, blurring boundaries and allowing (self) expression / communication. (SQ2). Effectively converting the concepts and research into a extimate technology prototype, made use of various ethical design thinking techniques. This allowed the ethical code to be deduced from the ideation concept, and this ethical code was then used to define the (non) functional requirements (SQ3). The final prototype, EasyJam, designed as a music-based expressive experience designed for all but specifically non-musicians, allowed users to communicate and express their emotions through music. The main challenge for this design was to ensure authentic expression using pre-made elements. User Testing confirmed that all intended emotions (from the audio prototype) were experienced by at least 50%, however the 70% majority agreement, as recommended in emotion recognition research, showed that only half of the audio elements met this standard (SQ4). Further trends certain emotions were more likely to evoke more than just the intended emotion, decreasing their “performance”. This should also be considered when setting a majority benchmark, as some designed emotions might not be able to reach it.

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Appendix A - Online Consent Form

Information & Consent.

Please read the following section carefully before providing consent.

Purpose of the Research

The purpose of this research is to understand how different audio elements and moods align with user expectations. This will help in developing a technology that allows users to express themselves through music by combining various musical elements.

Benefits and Risks of Participating

Some participants may experience slight discomfort when expressing emotions or evaluating music. If you have experienced emotional or other significant discomfort while listening to music, please re-consider participating in this survey. Participants are also at risk of hearing damage if listening to the audio clips too loud (on their headphones). There are no direct benefits to you for participating. The results of this study will contribute to the development of a more intuitive and emotionally resonant music-creation tool.

Participants can withdraw from the study at any time without any consequences. To withdraw, simply exit the survey and inform the researcher.

Personal Information Collection and Processing

- Data Collected: Demographics, Emotional responses to music, mood ratings and open answers about moods and feelings.
- Purpose: To analyze the users relation to music and alignment of audio elements with user mood expectations.
- Rights: Participants have the right to request access to, rectification, or erasure of their personal data at any time.

Usage of Data

- Data will be used exclusively for research purposes.
- Personal information will be anonymized and stored securely. Any quotes and statistics used in the report will be anonymous.
- Access to data will be controlled, and data will be archived for potential future research and publishing.

Retention Period

Research data will be retained for two months to create anonymous data (including age and gender), and then it will be deleted (by August 2024).

Contact Details

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- Ethics Committee: Ethics Committee Information and Computer Science, ethicscommittee-CIS@utwente.nl
- Institution: University of Twente

Contact Information for Questions about Your Rights as a Research

If you have questions about your rights as a research participant, or wish to obtain information, ask questions, or discuss any concerns about this study with someone other than the researcher(s), please contact the Secretary of the Ethics Committee Information & Computer Science: ethicscommittee-CIS@utwente.nl