Exploring emotionally evocative experiences with sound

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Abstract

In our relationship with the world around us, emotions play a vital role. As technology has become increasingly integrated and influential in our daily lives and activities, the design of systems that can support the human experience is of high interest.

This thesis explores how the emergence of emotional response in sound-based interaction can be facilitated. Through an exploratively based design process three affectively inspired soundscapes are designed. The states they relate to are Happiness, Sorrow and Fear. The experience of interacting with the soundscapes through ultrasonic distance sensors is then evaluated through three user testing sessions. The findings from this points to potential in the use of affectively aimed soundscapes to facilitate emotional response. Further, the findings indicate that levels of abstractions in subjective experience allow space for personal interpretation making for a more involving experience. The importance and potentials of contextual influences are also highlighted.
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1 Introduction

In our everyday lives our emotions play a vital role. Our emotional states influence not only how we act and respond to situations, but also our relationships, perception, reflection and experiences in and of the world around us (Cernea & Kerren, 2015). This takes place not only on a conscious level, but also on a more instantly felt, visceral one as well. The inner workings of subjective experience and response are not always easily traversed. While we as humans share common ground in our ability to feel, the mechanics and reaction we have are not always easily understood even by ourselves. As technology has evolved and integrated in our everyday lives, the way it supports and facilitates the human experience continues to be of interest, and it’s here the interest for this project is formed as well.

Affect and emotion in interaction design started to gain interest in what is referred to as the third wave of human computer interaction (HCI) (Bødker, 2006; Lim, Donaldson, et al., 2008). In this third wave, technology moved into the homes and private lives of people instead of being mainly reserved for the workplace. This presented a shift in interest from efficiency to the value of more personal experiences for users (Bødker, 2015).

Since this initial surge of interest for the emotional and affective dimension in design, the way we live and interact with technology has evolved and with this our relationship to it as well. As technology has moved towards more human centric and experienced valued interaction, there is space to explore how we can evoke affective experience to gauge meaningful experience (Bannon, 2011). In working with a focus on affective and emotional dimensions, technology made to support, encourage, and aid users in their own experience can be created.

1.1 Background

Inspiration for this project partly stems from work previously conducted at Malmö University with fellow colleagues. The projected was called Jellyfish Drum and was an audiovisual installation inspired by deep sea bioluminescence. It was centered around novel means of interaction, engagement, and immersion. Through this project a curiosity was formed around experience that is not goal-oriented and more experientially focused. It also uncovered queries around the felt experience of this type of interaction, and what it is that creates the pull that draws the user into it. From these initial queries and thoughts, interest around how affective and emotional states can be designed towards arose. How one can design for a viscerally felt reaction that can then turn into further immersion. An interest for the use of sound as a sensory input in these types of experientially focused interaction also manifested itself, which became a central part of the work produced in this thesis.
1.2 Delimitations

The field of affect and emotion in design is quite broad, and rich in both theory and approach. An important delimitation worked with in this thesis lies in the way in which affect, and emotion is handled. The work conducted in this thesis is not going to be focusing on the detection, sensing or interpretation of affective states as an input for design. Rather, it will focus on designing for affect and how this can be achieved through a sound-based interaction. While detecting emotion also serves purposes for support of human activity, having systems that does not infringe their interpretations on the emotional expression is also important. The large role emotions play in our lives should be embraced and engaged with in a way that allows freedom of those sensations, and not only used as data entry points to promote efficiency.

The work done in this thesis is solely focused on experience with sound, as opposed to other primary sensory means for experience such as light, smell, touch or taste. As each of these sensory fields offer much to explore, limiting the context to that of sound has helped guide the explorational focus of this project. Through this focus on sound, it has also allowed for a deeper understanding of the use of sound in this context.

As for the definitions of the terms of ‘affect’ and ‘emotion’, Fritsch (2021) distinction of these have been accepted. This will be further presented in the Theory chapter, section 2.1.1.

1.3 Aim

The aim of this thesis is to explore how an affectively guided and emotionally evocative experience can be designed for with sound as a sensory input. This in turn is done to generate knowledge around the emerge of emotion in interactive experience, and how the notion of affect can be used to guide this.

1.4 Research Question

What does it take to create a type of sound-based interaction that evokes an emotional response?

1.5 Structure of thesis

The first chapter of the thesis presents a theory review within the fields of affective and emotional design as well as different dimension of experience. In the next chapter the methods used during this project are presented. Following this is the design process of the thesis. The process has been divided into two chapters for the sake of clarity. First is the design exploration, detailing initial steps and exploration of soundscapes. The next chapter details the prototyping, user testing and evaluation based on findings from the exploration. After this there will be a discussion and evaluation of
2 Theory

In this section theory related to affect and emotion will be presented to gain further understanding for how these concepts have been approached in interaction design. Theory around different dimension of experience will also be examined for their relevance in the understanding of creating affective and emotional interaction.

2.1 Affect and Emotion in Interaction Design

As previously stated, affect and emotion as topics for interaction design gained popularity as the role of technology expanded into our everyday lives. This shift is discussed as occurring in the third paradigm shift within the field of HCI (Bødker, 2015). The previous paradigms have, to put it briefly, moved from questions of automatization and man-machine relationships to that of considering and including the complexity of human context into design. As technology has become an increasingly more prominent and interwoven aspect of everyday lives, the contexts, and purposes of it has also diversified accordingly. Bannon (2011) argues for the need to address these complexities through design to facilitate meaningful experience and the mediating of this through technology. The integration of everyday life and technology has only become more prominent since then and the relevancy of how technology can enable and enrich the human experience are still relevant (Kitson, Prpa, & Riecke, 2018).

In the following section, some background will be given on the theoretical basis for affect and emotion in design stemming from this. First, a brief description of the definition of how terms of affect and emotion are defined in this thesis will be given. This will be followed by looking at two seminal works within these topics, followed by critiques and other work developed both from and in response to this. This also helps to illustrates the broadness of approaches within interaction design as a field.

2.1.1 Defining Affect and Emotion in this project

There is a need to define some of the terminology that will be used moving forward in this paper. This has been done through research in existing theory surrounding emotion and affect in interaction design. The terms of *affect* and *emotion* are used in a wide array of ways throughout a lot of works, making the understanding or even separation of the terms confused at times (Cernea & Kerren, 2015; Fritsch, 2009; Lim, Donaldson, et al., 2008). Moving
forward I have accepted the definition of the terms as described by Fritsch (2021). Affect is separate from emotion. Fritsch (2021) defines emotion as “recognized affect”, it has been consciously formed and is therefore identifiable. Affect, on the other hand, is in the pre-state of emotion, unconscious and pre-personal. Affect, as explained by (Fritsch, 2021), is not a fully social, mental or cultural process. As such, affective experience exists in-between all these factors, adjusting the felt experience and action upon this. He also emphasizes that emotion is not the only associated term to affect. For the purposes of this thesis however, it is the one that will be focused on as colored by affect. Both terms of affect and emotion will be used throughout this project, as they are closely related and intermixed in the type of interactive experience explored. Affectivity in a way working as the entry point for the emergence of emotional experience.

2.1.2 Affective Computing and Emotional Design

In her book Affective Computing, Rosalind Picard (1997) argues for the importance of emotions in human decision-making, perception and understanding, making it a central question for the future of computer science. In her work she discusses the need for emotional understanding, perception, and intelligence in computers to create successful and fruitful interactions between humans and computational systems. Without emotional intelligence, she argues, machine intelligence cannot fully be realized. By working with giving computers the ability to recognize, respond to or create affective states and phenomena this could be done.

Putting this type of importance on emotion in human cognition was a relatively new way of thinking of the human mind. Moving away from a previously more information-processed view on cognition (Aboulafia & Bannon, 2004). Picard’s (1997) work played an instrumental role in positioning the question of emotion and affect as one of importance for the field. In doing this, she also introduced new possibilities for future research this could entail.

Another instrumental theory in this field of work is Emotional Design as introduced by Don Norman (2002). Similarly to Picard (1997), Norman (2002) also argues for the importance emotion play for our everyday lives and decision making. Norman introduces his three-level model of emotion as a way to understand, and in extension design for, emotion and affect as active dimensions of design. The three levels are as follows: the visceral, the behavioral and the reflective. The visceral level relates to the quick decisions and judgements we make, such as good or bad, safe, or dangerous. The behavioral level is where human action takes place. The reflective level is where the conscious reflection happens, which in turn affects the behavioral level. It’s the reflective level Norman (2002) argues is what sets us humans apart; our ability to consciously develop and affect our own behavior. We are
not purely driven by our visceral instinct but can consciously override them. Through this model of emotions, designers can create designs that evoke positive associations and experience of and with a product. Similarly, more negative affective states can be evoked in systems that require serious concentration.

2.1.3 Discussions, Critiques and Alternative Models

Today, it is close to impossible to find work done on affective or emotional design without either Picard’s (1997) or Norman (2002) work mentioned in some capacity. By discussing and proposing new ways of designing for and with human emotion in mind, both of their work has been highly influential in the field of affect and emotion within interaction design.

With that being said, neither concept of emotions and affect has gone unchallenged (Aboulafia & Bannon, 2004; Boehner, DePaula, Dourish, & Sengers, 2005). A reoccurring criticisms directed at Picard’s work in Affective Computing (1997) is the way she treats emotion and affect. Boehner et al. (2005) argues that the way Picard (1997) is approaching affect is recreating old ways of information-based cognition; treating affect and emotions as something transferable: units of information to be sent between human and computer without any measurable loss. Similar critique is directed at Norman’s model of emotions as well, and its replication of emotions as an additional aspect to an information-processing view of cognition, presenting emotion as being something purely individual and internal (Boehner et al., 2005). Instead, Boehner et al. (2005) proposes a model for affect as interaction, rather than information. Instead of emotion being something internal, individual, and transferrable they present other dimension of emotions being dynamic, culturally mediated, and socially constructed and mediated (Boehner et al., 2005). Treating emotions as an internal and measurable phenomenon they argue is reductive and disallows the true nature of emotions which are both ambiguous and complex. Computational systems should be designed to support human experience and explorations of one’s own emotional life, not just to sense and replicate them. In accepting and embracing the ambiguity, subjectivity and inherent difficulty that affective and emotional states poses is also how designers may be able to incorporate them in meaningful ways in design.

An example of how the models have been worked with as a means for exploration, Lim et al. (2008) used Norman’s (2002) three levels of emotion to explores how to design for emotion in experiences with interactive products. Through their work they identify different qualities of interactive products and how they relate to the different levels respectively. They argue that while emotional experiences through interaction can happen by accident, through the design of specific qualities that relate to different levels, emotional experiences can be influenced. Fritsch (2009) proposes the
concept of affective engagement as a potential resource for interaction design, more specifically for interactive environments that aren’t task oriented. Fritsch argues for the lack containment of affect and the inherent issues there is when designing for it:

“Affect is not something that can be transferred from an object to a subject; it is an event and part of every event, and it plays out differently in specific situations.”

Similarly to Boehner et al. (2005), he adapts the viewpoint that affective experience is not rational but rather a resource that needs to be understood as the opposite in order to be able to design for meaningful interaction. Fritsch (2009) discusses experiential fields as a space for opportunity for affective engagement. Through these fields, affect can be situated in relation to context, subjectivity and emotions and used to examine how we orient ourselves in the world depending on these nonconscious dimensions.

The role of emotion and affect in interaction design has been of continued interest in the design community but perhaps more as dimensions in design experience (Cernea & Kerren, 2015). Much of the theory brought up so far in this section is from around the initial surge of interest in the topic. While emotion has continuously been used to foster relationships between products, services and their users, the centrality of emotion in the human experience has somewhat changed trajectory. An interest in the detection and reading of the emotional states of users to respond, adapt and evaluate interaction and relationships to technology has emerged (Cernea & Kerren, 2015). Using emotional dimension as a leverage for productivity and efficiency in both work and well-being. This is not too far off from the initial topics of interest as brough up by Picard (1997).

2.2 Experience

Experience in and of itself can be difficult to describe as it fluctuates in its nature depending on where, how, and when said experience takes place. Buchenau & Suri (2000) described it as the following:

“Experience is a very dynamic, complex and subjective phenomenon. It depends upon the perception of multiple sensory qualities of a design, interpreted through filters relating to contextual factors.”

Experience and meaning-making gained focus in the same paradigm-shift that brough on the previously mentioned interest for emotion and affect in interaction design (Bødker, 2015). This came from a re-framing of technological purpose in the everyday lives of people and prompted new more user centric ways of design to be researched for and introduced (Bannon, 2011). Forlizzi & Battarbee (2004) argue for the importance in understanding experience when designing interactive system. Central to the human
experience are emotions, which both help guide us and evaluate lived experience. Over time, our relationship with experience unfolds and the way we remember it is dependent on either the scale or emotional importance it had. Emotions are a way to understand and communicate experience itself. In a similar way, Hassenzahl et al. (2013) discuss the when, where and what of experience as three dimensions used to make sense of an experience after the fact through a form of storytelling of it. They also emphasize the importance of affectivity as central to experience, and how interest should lay in where this stems from.

The design of experience is inherently dependent on the context in which it takes place and by whom it’s experienced. When exploring non-goal or task specific interactions, it is dependent on the subjectivity of the participant, and what they carry with them. These subjective and contextual factor are also subjected to change over time (Buchenau & Suri, 2000) which inadvertently carries an effect over the sustainability or re-experiencing of particular experiences. Nevertheless, if the experience is designed, one can also employ ways of designing certain contextual factors of it. A constructed experience is not the same as a spontaneous or naturally occurring one, in which these factors are more difficult to construct or facilitate. The relevance for this in this thesis lies in understanding the mechanisms of an experience and the factors that influence its emergence.

### 2.2.1 Aesthetic Experience

Aesthetics in design relate to more than the visual form of it. The aesthetics of experience can be seen as relating to the felt qualities of interacting with a product or a system that goes beyond just functionality and efficiency (Löwgren, 2009). The interaction itself should also be pleasurable and beautiful. The way in which aesthetics in interaction and experience is approached within interaction design varies. Ross & Wensveen (2010) argue for the importance of designing for aesthetics in interaction as the felt behavior of systems influences people, as people can influence them. This creates and exchange between product and user. The aesthetics should be a way to approach and design for this, introducing ethical and social consideration into the design of interactive experiences. The way Ross & Wensveen (2010) proposes to look at the central principles of aesthetic interaction resonates with this project and will be further addressed in the Methods section 3.3.1.

### 2.2.2 Immersive Experience

Immersion has been widely defined and used between many different types of experiences (Agrawal, Simon, Bech, Bærentsen, & Forchhammer, 2019; Kitson et al., 2018). In the same way experience is dependent on contextual factors, immersion can be argued to be dependent on the experience itself. Different settings for immersion demands different means of creating the possibility for immersion. Agrawal et al. (2019) suggest a definition of
immersion as being the state an individual experience while being so deeply and mentally involved that they may experience a detachment from the real world. In this definition they also include that it is not necessarily sensory dependent, as you can get immersed in daydreaming or books without being subjected to sensory stimuli. They further use two set of framings to illustrate their definition: *Immersive potential* and *Immersive tendency*. *Immersive potential* relates to the potential of the system to facilitate states of immersion, while *Immersive tendency* relates to the likelihood for the participant to enter an immersive state (Agrawal et al., 2019). These are factors which has an impact on the potential for immersion in an experience. This definition of immersion has been adapted for the purposes of this thesis as well.

### 2.2.3 Interactive art

The world of interactive art represents a relevant intersection for concepts of experience, immersion, and aesthetics. This also positions it as a relevant to address in connection to this project. In interactive art the traditional viewer is invited to take part of the artwork, either in a controlling or co-creating capacity. There are number of ways this interactivity can be approached, making it somewhat difficult to exemplify it. As art traditionally can be seen as being dependent on its viewer, it poses an interesting space for communication and reflection between artwork and viewer, or participant. As noted by (Höök, Sengers, & Andersson, 2003), the evaluation of the interaction happens by the person viewing the art. In this aspect it differs from how evaluation is done in the world of interaction design. As art exists within the compound of the art-world, a different set of evaluations is used, and a different set of expectations can be placed on the purpose of the interaction itself. Art is also a space were introspection, reflection and emotional responses can be encountered. In the related work section, the closeness interactive art plays to this project can also be seen.

### 2.3 Related Work

In this section projects that relate to the topics treated in this thesis are presented. These have been chosen as ways to illustrate how concepts and experiences centered around of immersion, affect and emotion has previously been designed for and with.
2.3.1 Miro

Figure 1 Blue I by Joan Miro (Miro, 1961).

Miro was a display installed in an office building to provide the workers with an overview of the overall emotional state of the office (Boehner et al., 2005). People who worked at the office would report their own emotional states throughout the day at emotion stations placed around their workplace. The data from these stations would then be compiled and interpreted into animation of an abstract painting called “Blue” by Joan Miro (Figure 1), making the shapes behave differently depending on it (Boehner et al., 2005). This display could then be viewed and interpreted by the office workers. While the aim was for the users to gain an understanding of the abstract display’s language over time, the actual use of it went differently. As discussed by Boehner et al. (2005), the language of Miro made little to no sense to the users. However, it did work as a trigger for reflection as the workers created their own affective interpretations based on their personal knowledge of the office, often reading it quite differently than the actual data it was displaying. Boehner et al. (2005) sums it up quite nicely with the following reflection:

“Oddly, Miro fulfilled its designers’ intentions of encouraging reflection on emotional climate, but not in the way the designers intended.”
2.3.2 Aura

Aura was an audiovisual installation created by Nick Verstand (Verstand, 2017). The installation was centered around externalizing individuals’ emotional states using light beams (Figure 2). To interact with the installation, visitors wore different biometric sensors that collected information through brainwaves, heart rate and galvanic skin response. As part of the installation, a musical composition was played to influence the emotional states of the participants (Verstand, 2017). The installation supported several users at once, creating a larger social display to be viewed by others. The data collected from the users was then interpreted into the behaviors of individually placed light beams, changing color, intensity, and shape accordingly.

While it could be argued that Aura lies closer to art than interaction design, I have chosen to include this piece of work for the affective treatment it is centered around, playing with creating and supporting affective states as a salient part of the installation. As the internal is made external, a space for self-reflection and immersion can be created. By placing it in a public space it is also incorporated social dimensions, further playing with the contextual factors of emotional emersion.

2.3.3 The Living Tree

Figure 3 Microhabitats (Blichfeldt, Komang-Sønderbek, Westergård, & Fritsch, 2018).
The Living Tree (Blichfeldt, Komang-Sønderbek, Westergård, & Fritsch, 2018) was an immersive interactive audio installation, created in collaboration with the Danish Nature Agency. The installation consisted of three different soundscapes which were connected to real-life tress. The sounds were accessed by pressing an ear to the trees. This was done with the use of surface transducer that transformed the trees surfaces into speakers through vibrations. Through the soundscapes users could explore different aspects of a tree’s life. In *Time Tree* the age of the tree was in focus, inviting users to listen to different historical sounds the tree might have lived through. *Microhabitats* focused on the biodiversity trees support (Figure 3). *The Living Tree* was a more abstract interpretation of the inner life of a tree, creating an ambience and personality, giving the tree a response to how it was approached. The soundscapes were explored through climbing and touching the trees in different ways. The aim of this was to encourage visitors to think of the forest and trees in new ways, and strengthening the relationship through affective engagement (Blichfeldt et al., 2018).

### 3 Methods

In this section methods from the field of interaction design that has been used in this thesis are presented. Since this project is focused on an exploratory process the selection of methods reflects this practice and has been chosen to support an open-ended work process.

#### 3.1 Research Through Design

As introduced by Zimmerman, Forlizzi, & Evenson (2007), research through design is a model for interaction designers to conduct exploratory research through the creation of investigative artefacts. In this model, the driving idea is that of utilizing the inherent strength in a designer's specific skill set allows the process more freedom. In doing this, designers can then use the artefacts as embodiments of inquired knowledge making it possible for researchers and designers of other disciplines to take part of it. The model also provides four lenses through which the artefacts produced should be evaluated: process, invention, relevance, and extensibility.

**Process** relates to the design research process being well documented enough for it to be possible to be replicated by others. The specific methods chosen must also be explained and motivated.

**Invention** points to the novelty of the work done in relation to the research community. This should be done through addressing a specific situation and its relation to the surrounding field through literature and other work, articulating the possibilities this presents.
Relevance is used to evaluate what “preferred state” the designer wants to achieve with their design work, and why this should be considered as preferred for the rest of the community as well. This should be framed around the impact in the world, and not the personal importance for the designer (Zimmerman et al., 2007, p. 500).

Extensibility is how well the work can be further built on by fellow designers and researchers. For this to be valid, the design work needs to be well documented and formulated enough for the work to be able to be used by others.

As the topic of this project is centered around an exploratory approach and inquiry into how to design for an emotional experience, this model is well suited to employ design research through, and also why it was chosen to work with as it provides a good foundation through which to evaluate both the process and results.

### 3.2 Sketching

Sketching is an inexpensive tool for expression and reflection that supports designers in working through ideas and design spaces (Tholander, Karlgren, Ramberg, & Sökjer, 2008). Through sketching, ideas can be explored in an inexpensive manner saving time and resources making it a suitable method for early stages of prototyping and research to guide the research process (Buxton, 2007, Chapter 13). In this project sketches have been produced in different capacities throughout the design process as a means for reflection, problem solving and communication. During the conceptualizing of the prototypes, sketching was also a tool for technical exploration and decision-making to work through ideas before testing them in a more physical manner.

Sketching as an activity is not necessarily reserved for paper and pen but can be done with a wide variety of materials, physical or digital alike. Buxton (2007) argues the focus should rather be on the “imagination and understanding” involved in the activity itself (Buxton, 2007, p. 135).

In this project I will refer to some material as digital sketches. These were used as testing components in the first part of the design process. By using pre-made sound clips, they were put together for inexpensive and more time-efficient exploration into soundscapes.

### 3.3 Prototyping

Prototyping is commonplace practice in interaction design. Through the making of prototypes, designers can evaluate, question and test different aspects or qualities of a design. Additionally, prototypes are a way for designers to explore and refine the design space they inhabit (Lim, Stolterman, & Tenenberg, 2008). In combination with the many ways prototyping can be approached, both regarding material and fidelity, it makes for a powerful tool for inquiry and iteration during the design process.
Prototyping has been employed throughout this design process as a means of exploration and to examine possibilities and experiential qualities. Buchenau & Suri (2000) present experience prototyping to think about prototyping for experiential aspects of a design. Emphasis is put on prototyping in a manner that enable direct use by both designers and users of the experience itself, rather than through observation. This stems from the position that experience is inherently subjective and needs to be addressed as such (Buchenau & Suri, 2000). This point of view works well for the prototyping in this project as well, as the objective of exploring a specific type of experience is in focus. The prototypes created for this project were all built to function and to be properly interacted with in a live setting, as the focal point is in that of the experience itself.

3.3.1 Analysis of prototypes

To aid the analysis of the prototypes produced, the four principles of aesthetic interaction as presented by Ross & Wensveen (2010) have been used as a guiding tool when evaluating my work. The principles are as follows:

**The practical use and intrinsic value**, while aesthetic interaction should be rewarding in and of itself, it should also hold a practical value of use.

**Social and Ethical Dimensions**, as beauty is subjective the way in which aesthetic interaction is designed should consider this potential on different peoples experience of it. Additionally, as aesthetics can be used to influence behavior the ethics of this should be considered as well.

**Satisfying dynamic form**, form in this context refers not necessarily to the physical shape of the product or system, but also to the dynamic aspects of it in interaction as something to strive for.

**Involvement of the whole body**, as experience of beauty is not limited to internal contemplation, the involvement of the body as whole is needed to create a fully aesthetic experience. The design should strive to include aspects of both mental appreciation as well as physical involvement.

According to Ross & Wensveen (2010), these four dimensions of human skill are integral for the creation of aesthetic interaction. These dimensions fit well within the context of my project and resonate with the aim of this thesis. In focusing on experience with an affective and emotional perspective, using these principles helped to anchor the work and as well as to guide the design process.

### 3.4 User Testing

Through user testing, information of the experience and usability of a design can be gained through the accounts of testers. Making use of different prototypes in user testing can provide feedback on aspects of a design and insight into what works, what doesn’t, and why (Kuniavsky, 2003).
In this project, user testing has been used to further understand experience through the personal account of testers, and to be able to evaluate the design decisions made. As previously stated, subjective experience can be difficult to articulate and difficult to predict as it varies between people. Through user testing different accounts on the ‘same’ baseline experience can be collected and compared to determine how different responses can be elicited. This also allows for valuable takes on the experience tested to make visible aspects that might disrupt or disengage the user from the interaction. Such, the aim of user testing has not been focused on the performance of specific tasks or goals, but on the interaction and experience of this.

3.5 Self-reporting

Understanding experience of users is central in design. This understanding is in turn dependent on the account provided by the users themselves (Doherty & Doherty, 2018). Through self-reporting of experience, users’ perspectives on how an experience was consciously perceived can be collected. It is then the designer’s job to interpret this to formulate insights. The focus on subjective feelings through self-reporting was used both as a method to extract my own subjective experience, as well as to gather that of others in the scope of this project. Through this the way in which one gets to associate and discuss their own experience is open to be expressed as seen fit by each participant.

Doherty & Doherty (2018) suggests a model for the Consolidation of Experience to illustrate the relationship between the self and the experience. This is done to address the complexity and multidimensional aspects of experience and do guide the way in which to understand and construct self-reporting. The three concepts they present are the experiencing, remembering and future-oriented selves (Doherty & Doherty, 2018). This provides a way of interpretation of experience, the framework a way to understand experience as it’s “lived, remember and envisioned” (Doherty & Doherty, 2018, p. 4).

Since this project is not focused on the actual measuring of emotional states, the users taking part of the testing were asked to report on their own subjective feelings to collect information on their experience (Cernea & Kerren, 2015). This was done through note taking by the participants during and in-between testing. After the test concluded a semi-structured interview (Kvale, 2007, Chapter 5) was also held regarding the experience, using the notes as a basis for conversation. The semi-constructed interview allowed for a base of questions and themes to be covered to gain information on the real-world perspective of the person being interviewed. Still, it was kept open enough for the topics to be able to be modified depending on the answers given (Kvale, 2007).
4 Design Exploration

The design process of this project is divided into two main sections. In this first section I will focus on the first phase of the design process which consisted of exploration done with technology. In this exploratory phase no other participants other than myself were involved, instead made use of my own capabilities of feeling and reflecting on experience.

The initial interest for the topic of emotion and affect in interaction design, and how to create this type of interaction is quite broad. This made the starting point for my exploration very broad as well. In my initial efforts, I attempted to see how a generally emotionally charged experience could be created. I tried exploring relationships and more distinct emotional attributes as a way into this but felt the focus of the exploration was too diffuse and large for me to handle in this scope. Going of impressions gathered both through the previously mentioned Jellyfish Drum and the work in the section of Related Work (Chapter 2.8) of this paper, I tried to find traits of these experiences through which I could explore a more gut-level and visceral reaction. In doing this, the sensory input of these works became quite apparent, specifically in the form or touch, sound, or light.

4.1 Sound

When looking over the possibilities for sensory involvement, I took an initial interest in using sound as a material. This was strengthened after reviewing some of the works and related topic of sound and interaction (Blichfeldt, Komang-Sønderbek, Westergård, et al., 2018; De Witt & Bresin, 2007; Fritsch, 2009). Sound has the ability to carry a lot of meaning and associational power, making it interesting in the context of trying to create an experience focused on the subjective and viscerally felt (Donato, Dewey, & Michailidis, 2020). By using these built-in qualities of sound, I wanted to see how if it could aid the process of creating the emotional dimensions I wanted to explore. Because of this potential in associative power in sound I decided to let it guide my exploration moving forward. Since the field of sound is rich in and of itself, I also decided to limit myself to the use of sound rather than combining it with other sensory inputs at this stage. When referring to sound here I have focused on sounds as an environmental factor in experience. For example, the many different everyday soundscapes that surround us on a daily basis, consisting of the things we do, touch, pass, or use or the environment around us (De Witt & Bresin, 2007).

4.2 The Interaction

When approaching the interaction itself, emphasis was put on freedom to experience and feel the interaction. In deciding to use sound as the central output, the idea of it fed into a sense of environment and scene building. When
working with figuring out how to approach this sense of openness in the interaction itself I considered some different sensors and means of input for this purpose. Since the only form of output would be sound-based I didn’t feel the need to introduce a heavy amount of interaction possibilities in this first round, but rather felt intrigued to see how I could interact with sound in a somewhat head-on manner. This led me to try the ultrasonic distance sensor as a primary way of interaction. While the sensor itself is quite simple, it affords possibilities in spatial and hands-off experience as it reads the distance of the user rather than needing direct manipulation. When testing it with small, random sound clips for function, it became noticeably more diversifying to engage with compared to tests done with buttons, dials, or pressure sensors. In the latter the interaction possibilities felt more static.

Figure 4 Illustration of interaction space set-up with the ultrasonic distance sensor.

When positioned in different distances from the proximity sensor (Figure 4), sounds would play depending on the distance. I used this as my basis for the interaction.

4.3 Sketching Soundscapes

I aimed to explore sounds which could evoke a more dimensional sense of interaction. By creating representations of different real-life spaces that could (subjectively) create a strong ambience or sense of immersion I wanted to focus on creating charged scenes of sounds, piggybacking on qualities of personal feelings and associations. These scenarios are spaces or events which naturally elicit a visceral, gut feeling response when experiencing it. Moments and places that can naturally place you in a state of reflection, peace, or introspection. As a basis for this ideation, I used my own personal associations and experience to guide the process. By focusing on these types of subjective experience I wanted to use them as structures for how I could approach creating a soundscape of my own that could then be interacted with.

Through ideating with pen and paper I first ideated freely on spaces I would consider relevant for this. After looking over the collected experiences or places, two main categories were formed: nature and old buildings. Nature
have traditional ties to the meditative and relaxation, as well as reflection and introspection (Kitson et al., 2018) making it a suitable source of inspiration. Old, historic buildings as a space is once again brought forward from subjective experience, relating more to the sense of being surrounded by something larger than oneself, a commonality in the idea of nature experience as well. This also made for two contrasting experiences: the man-made and the naturally occurring.

Using these two larger special categories I created two scenarios to use in my initial soundscapes: Rainstorm and Choir. To enable me to make quick and inexpensive sketches of the soundscapes I used free pre-recorded sound-clips from Freesound (www.freesound.org) for this. This way I could assemble the imagined scenes without having to create them from scratch. The way the soundscape sketches were specifically constructed will be detailed further ahead in this chapter. In the outcome section of each sketch a link is also provided to a short video demonstration of each soundscape.

4.4 Set-Up

The technical set-up consisted of the ultrasonic distance sensor HC-SR04 as input. The input was connected to an Arduino Micro which sent distance values to p5.js, which then handled the playing of sounds. In none of the tests was the sensor, computer or speaker obscured or dressed in any way, but rather just placed differently. For these soundscapes the only speaker used was the built-in laptop speaker and with the sensor placed on the desktop next to it (Figure 5). I used relatively short distance settings for these trials, the maximum distance being 60 cm from the sensor.

![Figure 5 Set-up of sensor with computer on desktop.](image)
4.5 Desktop Trials

4.5.1 Choir

**Composition and Intention**

The inspiration behind *Choir* was church. A big part of my own subjective experience of churches are the acoustics. Listening to singing in a church can be quite a powerful experience, which sometimes can cause this immense sense of immersion. By using this type of soundscape, the aim was to see how interaction influenced the perception of it.

The soundscape consisted of five different clips of choir singing. One criterion used for picking them out was both length and ambience. One of the clips was a bit longer to create a foundational sound, while the others were kept relatively short as to not get stuck in them. All sounds used were under 10 seconds. I also did this to work with the layering abilities of sound, aiming to make something that didn’t feel too disruptive. I placed the longer sounds on the outer perimeter of the sensors range, so that the foundational sound was triggered first and as one moved closer the sensor the shorter ones could be layered more frequently. The clips were also paired in a way that varied an intensity between the singing. By doing this, the intention was to create a build-up between the sounds themselves, creating a sense of dramaturgy.

**Outcome**

The different clips of singing worked well together, creating an unexpected sense of dimension and control when interacting with it. While some parts of the clips became repetitive, the overall impact of layering them by changing distance to the sensor was enjoyable and encouraged one to stay with them. While I was aware that I had no actual influence over the sounds themselves, the way the singing weaved together created a sense of control and ability to increase the singing. This was somewhat unexpected since the sounds did not garner quite the same feel of dimension when selected. Rather, the sense of responsiveness came about from the interaction with the sensor making it intriguing to interact with. However, the shortness of the clips did create issues with repetition after some time, making interest in the interaction decline and the interaction to end. This was interacted with using one hand. I found that that the singing afforded a quite soft approach to the movement in front on the sensors, tapping into the feel of conducting the sounds.

4.5.2 Rainstorm

**Composition and Intention**

In *Rainstorm* the concept was focused on the impact of something powerful and (otherwise) uncontrollable in a sense. The sound of a rainstorm can create both feelings of comfort and fear, making it an interesting scene to engage with in this prototype to gauge reaction. *Rainstorm* consisted of sounds of dripping, heavy rain, wind, and a thunderclap. The sounds were not longer than 10 seconds, except for one that acted as the foundational sound. This was played when the sensor was triggered on the furthest distance. By choosing some clips with different amounts of sound in strength I also intended to try more of a sense of buildup of the rain, with the wind and storm increasing.

**Outcome**

While the increase of rain and overall storming did evoke some sense of power and grandeur, the sounds were quickly over and felt quite uninvolved to try and interact with. Repetition of sound also became extremely obvious in this soundscape making it difficult to want to stay with it for any longer period. It felt more like a novelty than an experience and my own role in the interaction was both quite impersonal and static.

Video *Rainstorm*: https://youtu.be/BS9MMj4-9ig.

4.6 Desktop Comparison

When comparing the experiences of *Choir* and *Rainstorm*, there are some differences worth noting. The layering compatibility in the sounds in *Choir* allowed for the interaction with it to be longer, and it felt more dimensional and fun to interact with in that sense as it had more to it to explore than in *Rainstorm*. Overall, this created a more intriguing experience between the two. While *Rainstorm* did feel powerful and interesting in the very first touch with it, it quickly became quite uninteresting, and no sense of immersion could be felt.

Perhaps neither of them gained anything by being played through the computer speakers which did not aid any sense of powerful experience I intended to initially try and replicate.

4.7 Scaling Up

Moving forward I decided to scale the experience up by using a larger speaker. The distance parameters were also altered to respond to longer distances, opening for more full body approaches rather than close-range limitations. The distance was increased to 120 cm, as opposed to the previous 60 cm. In doing this I aimed to make the experience feel larger and see how it could potentially influence the feeling of interacting with the soundscapes themselves and whether it could aid potential feel of immersion. Both *Choir*
and Rainstorm are also modeled after quite large events that call for space rather than containment in their natural setting. The physical set-up of this was putting the distance sensor, computer, and speaker further out into a room (Figure 6). Two more soundscapes were also added: Forest and Steps. They were brought forward based on findings in the first two which will be more detailed in respective section below.

4.7.1 Forest

**Composition and Intention**

*Forest* was made up of five different sound clips. To create a calmer experience, the longer based sound used for this one was of forest ambience consisting of birds chirping in the distance, rustling and wind. To make the space feel less static, sounds of interference in the space were introduced; one of twigs breaking under a step being taken and that of leaves rustling. To add further to the overall ambience, I also included the sounds of wind blowing softly through the treetops.

The aim in *Forest* was to further explore the creation of a specific space, creating something less action oriented. A soundscape more focused around the being and staying in a space rather than an action-triggering one.

**Outcome**

The forest scene produced was perceived as larger in a physical sense. This could probably be attributed Partly because of the larger speaker but also in the height of the sounds. Since some were tall (birds, wind in treetops) and other ground level (leaves, cracking of a stick) it made the perceived space feel larger. This soundscape also afforded some more full body movement.
within the space, and it felt natural in a sense to walk in it and hear the snap of a twig or shuffling of leaves, sitting down, and staying for a bit.

There were two main issues with the scene. Firstly, it also suffered from repetitive issues which had an eerie impact on the whole scene itself. Second, the idea of having these forest sounds while inside did not make for a very long-lived enjoyment of the environment, but instead made it feel quite lonely and artificial. This paired with the repetition of sound also created an unsettling feeling.

Video Forest: https://youtu.be/0yIw0uHpmTY.

4.7.2 Steps

Composition and Intention

Steps consisted of a collection of different steps, steps on grass, the creak of a wooden plank, steps in a puddle, on stone, on gravel.

This soundscape was more ambiguous than the other three. In this trial the aim was to lean into the somewhat surreal experience of creating artificial reaction sounds. Since the repetition had proved to be a continued pattern that worked less well when unintended I wanted to examine how it could be felt in a more intentional way.

Outcome

The experience of this was jarring. The repetition of the steps made it feel uncomfortable and loud to be in. It also felt extremely linear. In this trial the technicality of the distance sensor was the most felt while trying to interact with it. The steps did not create a space for dimension in experience, but instead the information of it being steps tied into the ground in a flat way. There was not much room for interpretation or anything to go off. This is however the only set of sound which somewhat tied into the physical space it was placed in, like the creak of a floorboard which made for a somewhat new sensation. Since it did not try to mimic an exact place or scene, it effectively avoided feeling eerie in the same manner as in Forest.

Video Steps: https://youtu.be/xef-feFZ-JY.

4.8 Exploration Findings

These initial exploration into soundscapes served as ways to create experience through which I could see how it would feel to interact with sound, as well as how it could be used to construct experience aimed at evoking some sort of emotional, affective, or immersive response. To evaluate the experiences of this I compiled my own subjective reflection on each soundscape in short-handed impression and properties. Through this I wanted to see if I could extract some sense of commonalities between the experiences I had and the soundscapes themselves. Aiding me in this process
were also the principles of aesthetic interaction by Ross & Wensveen (2010) as introduced in section 3.3.1.

**Interaction**

The interaction itself felt rather uninteresting and linear. This had an overall impact on the felt experience of all the soundscapes, as the interaction with them in this manner felt very limited. There was a sense in all four soundscapes of being replaceable as a user, as I had no real impact over the interaction. While the hands-off interaction in how it afforded a sense of exploration, the linearity of the sensor was clearly felt in the interaction with all soundscapes. While the larger speaker contributed some to the initial impact of the sounds, the novelty quickly wore off as the interaction remained the same. The interactional aspects of this also relate to the aesthetic interaction principle of satisfying dynamic form (Ross & Wensveen, 2010). In the current state of this, no such dimension could be argued for being there, further emphasizing the need to evolve the interaction. Since it’s taking place without touching as an input, the form of movement and physical approach needs to be more encouraged in the way it functions. Another of Ross & Wensveen’s (2010) principles are focused around the involvement of the whole body (and mind). The possibilities for evolving this is tightly connected to complicating the interactional space as well to make use of the potential in body and spatial interaction.

**Emotional Evocation**

While the use of pre-made, in a sense, situations to shape the soundscapes did create a reaction of sorts, this was short lived and superficial. It did little to draw me into the experience, pointing to a large weakness in the experience of the soundscapes overall. There was a mismatch between the space they were placed in and the spaces they illustrated, making it difficult to garner any affective sensation from them or to even stay in them for a longer period. However, negative experiences are also a valuable finding in this. It created a response, which was also something I aimed to do. The social and ethical dimension of Ross & Wensveen’s (2010) also urges designers to keep an eye on the individual experience of the designed qualities and how they can be received by different people, which needs to be kept in mind moving forward as to not make exclusive or behaviorally disturbing designs. This also relates to the section below.

**Explicit and Implicit qualities**

When looking at the feeling of the soundscapes themselves I categorized the difference in experience to see how different qualities affected the felt experience. I freely noted down impressions and associations I made with the different soundscapes to aid my comparing between them. Through this I identified aspects relating to explicitly that set the soundscapes apart from each other.
Figure 7 shows a simple graph on which I placed the different soundscapes to illustrate the difference in conceptual explicitly between them. The level of explicitness was divided between two main parts that of the different soundscapes: event and scene. Event relates to the *what* of the experience, while scene refers to the *where*.

![Implicit and Explicit dimensions in event (what) and scene (where) of soundscapes.](image)

While the exploration of explicit sounds and soundscapes stemmed from an idea of making use of the inherent associational powers they carry, through the first round of exploration it also became clear that this carries its own set of issues. If the created soundscapes are too explicit, certain behaviors are expected from them. It is also difficult to engage with since it can be hard to create a sense of self in these types of scenes. There are contextual dimensions of emotional experience that also need to be adhered to (Boehner et al. 2005). The more explicit the soundscape, the less room for personal interpretation in the moment.

The more explicit scenes like Rainstorm and Forest, created an unexpected sense of eeriness, making the whole interaction unsettled. This could stem from the repetition of sounds which quickly drew attention to the unnatural sensation of it all. As they were also done on quite a small scale, with a small set of sounds used the experience of the scenes became difficult to stay in. The issues with repetition further drove the point of a pre-fixed experience making it difficult to partake in. Of the more implicit soundscapes, Choir was the one that had the most pleasurable experience. While it also suffered issues with repetition, it felt the more dynamic and alive. Steps, although more ambiguous in its whole existence made for a strangeness that could also
produce curiosity in what is happening. When looking at the interaction aesthetic principle of social and ethical dimensions (Ross & Wensveen, 2010), a valid direction seem to be to encourage the inherent diversity of subjective experience. Through this exploration it seems that a way to do this is by going in a less explicit direction with the soundscapes moving forward. Lacking in these set of tests is a more practical value, also stated by Ross & Wensveen (2010) as being an important component in the making of aesthetic experience, as to not cut it short at an appreciation of beauty.

5 Prototyping

After evaluating the findings of my experience and exploration of the four sound sketches, my aim was to utilize this in creating a larger experience-based prototype to test with users. After using my own perspective and experience to guide the exploration, I wanted to see how these findings would be experienced by other participants. This chapter will detail how that process looked, how the testing session was set up as well as the findings from the testing conducted.

5.1 Designing new soundscapes

From the insights gathered from the first round of soundscapes, three new ones were made. Through my experience with Choir, I realized that perception of the sound aided the felt dimension and impacted the interaction in a positive way. While the sounds used for Choir did not actually change depending on me, it still felt like they did, setting it apart from the other three sketches. This also guided the making of the new soundscapes in their abilities to be layered. If the layering could be done in a non-repetitive and complementary way, the experience could become more dynamically felt and become less likely to break down. The aim here was also to create an environment in which one could spend a longer amount of time in to potentially facilitate a possibility of immersion in the experience (Agrawal et al., 2019).

As a basis for the new soundscapes were three affective states: Happiness, Sorrow and Fear. Inspiration for this came from looking at suggested models for basic emotions (Cernea & Kerren, 2015). The choice of these three relates to their clear distinction between one another as well as the perceived richness of each. In doing this, the intention was to create abstract representation of emotions as interpretable and affectively charged soundscapes. By moving away from the specific sounds, and into more of an abstract direction when building soundscapes, the aim was to facilitate a longer and more immersive interaction with the soundscapes. Through this
abstraction I also wanted to encourage more room for personal interpretation and meaning making (Hassenzahl et al., 2013).

The new soundscapes are all made of original sounds made from the starting points of Happiness, Sorrow and Fear. The soundscapes are also longer, the sound clips varying in length between 3 and 19 seconds. These soundscapes were made in collaboration with a friend knowledgeable in sound design and application. This also allowed for his input on experience of the sound which aided greatly in the design and construction of them. As previously mentioned throughout this work however, representation of emotion is individual and subjective. This was also understood in the creation of the soundscapes and the objective was not to elicit specific emotion on use, but rather examine how these types of affective states could be interpreted and experienced by different people.

For this final prototype, Bluetooth headphones were used to hear the sound. This made for a better audio quality than my previous set-ups had. The headphones also created an intimacy on use with the sounds, putting the user in closer proximity to them. It also provided a more private experience as the sound could only be heard by the participant, closing off other sounds from outside. All the soundscapes were given a base sound of room ambience that plays throughout to create more dimension.

5.2 Evolving the interaction

The interactional aspects lacked dimension in the first set of trials and so I wanted to complicate the means for interaction moving forward. Since the functionality of my distance sensor was linear, I decided to increase the physical range of interaction by adding two more distance sensors. In doing this the space in which one could interact with the soundscapes increased and didn’t rely on a single axis. I also increased the maximum distance to 160 cm. The distance was decided on through trial and error. The sounds needed enough space to be engageable with on their own, but also be close enough to each other to be able to come together. This also allowed me to complicate the way in which the sound could be layered by dividing up different actions and sounds between the sensors. The aim being to make the interaction itself more involving and dynamic.

Two types of cases for the sensors were also added to this prototype. A standing type of case and one box shaped one (Figure 8), which were 3D printed. This eased the handling of the sensors, and aided stability. The box case also made it possible to pick up the sensor if wished. How this was implemented in the testing will be discussed further in Chapter 5.3.
Another point of interest was further interference with the sound itself. Being able to manipulate the sound quality could also enhance the sense of individual importance for the interaction, as the first set of trials pointed to an issue in feeling replaceable and uninvolved with the interaction. This was approached by making one of the sensors capable of applying a low-pass filter to parts of the soundscape. A low-pass filter sorts out the lower frequencies of a sound and distorts it, creating an interesting way to make a direct impact on the sound itself. Another sensor was used to play shorter sounds, for quicker impact on the soundscape in response to the user’s action.

**Sensor 1** contained the longer and foundational sounds, the bulk of the soundscape. The functionality was same as in the exploration phase: sounds played depending on the proximity to the sensor. I put the more intense sounds closer, and the more melodic ones further out to create suspense as you moved towards or in front of the prototype.
Sensor 2 had a range of shorter sounds. These could be played faster, and their length allowed them to be layered quicker than the longer sounds of the soundscape.

Sensor 3 was equipped with one specific sound file that could be manipulated with the low-pass filter if wished. The criterion for this sound chosen in each soundscape was its distinction from the others so it could be clearly heard and as it was manipulated.

Below links are provided to videos demonstrating the different soundscapes.

Happiness: https://youtu.be/k_Yqse4KP_M.
Sorrow: https://youtu.be/_XBPwTTGeik.
Fear: https://youtu.be/UOg8b-oKgJY.

5.3 User testing

The user testing was done with three students individually. All three tests took place at Malmö University, two in a closed off hallway space (Figure 9) and one in a more open space outside of office hours (Figure 10). The test consisted of the participants interacting with all three soundscapes one after the other in one session.

The participants were given restricted information on the experience as to not color the impression too much beforehand. The names of the affective states of Happiness, Sorrow and Fear were not mentioned but rather just referred to as three different soundscapes. They knew it involved sounds as headphones were provided, and sensors as they were clearly visible. While the interaction was taking place, I acted as an observer and took notes on the physical and facial language of the participant. As they were using headphones, I could not hear how they were doing in the soundscape but monitored that it was functioning via the computer.

*Figure 10 User test set-up in hallway.*
In one of the soundscapes of each test, the sensor casing for Sensor 2 (containing the shorter, quicker sounds) was switched to the box case. In doing this I wanted to see both how it impacted the felt experience as well as how the participants would use it.

As the prototype was focused around the subjectively felt experience the participants were asked to conduct the test in silence and focus on themselves as much as possible. When changing between the three different soundscapes they were asked to write down spontaneous impressions, thoughts, reflection, or associations they had when interacting with the soundscape. In doing this the intention was to catch in the in-the-moment-thoughts and reflections that could be forgotten or muddled after completing the whole test. The participants were asked to indicate themselves when they felt finished with each of the soundscapes as to not put any time pressure, or to force the experience. This also allowed me to observe how long the interaction felt enjoyable in a more natural way. Each of the sessions were timed by me as well to collect further information on this self-chosen time of interaction and enable comparison between the testers and soundscapes. After all the three soundscapes had been tested, a semi-structured interview (Kvale, 2007) was held with the participant. The notes they took during the test was then used as basis for conversation and discussion with them self-reporting their felt experience (Cernea & Kerren, 2015).
5.4 Outcome

After concluding the tests, the materials in form of the notes taken by myself and the participants, as well as from the interviews (Figure 12), were reviewed and compiled. Going through each soundscape I collected how each experience of the soundscapes was discussed by the participants and clustered the information around them (Figure 13). Three subcategories emerged from this. The first (pink) relates to the felt qualities of the soundscape as expressed by the participants, the second (green) of imagery which was used to discuss their experience, and the third (black) was the physical actions taking place during the interaction as observed by me.
As previously mentioned, each session with the separate soundscapes were also timed. This was done to gather data on the time spent interacting with each of them, and how and if it correlated between the participants. I compiled this into a simple table as seen in Table 1. This gave me an overview of how long the experiences lasted for each participant. In my initial explorations (sections 4.5.1, 1.5.2, 4.7.1, 4.7.2) the time spent within the soundscapes were all very brief, none of them facilitating an experience in which one would stay in for any measurable period.

<table>
<thead>
<tr>
<th>Participant</th>
<th>Happiness</th>
<th>Sorrow</th>
<th>Fear</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3m 37s</td>
<td>3m 58s</td>
<td>3m 36s</td>
</tr>
<tr>
<td>2</td>
<td>3m 2s</td>
<td>2m 16s</td>
<td>2m 16s</td>
</tr>
<tr>
<td>3</td>
<td>4m 38s</td>
<td>4m 5s</td>
<td>3m 47s</td>
</tr>
<tr>
<td>Average time spent</td>
<td>3m 45s</td>
<td>3m 26s</td>
<td>3m 19s</td>
</tr>
</tbody>
</table>

Table 1 Time spent by participants in each soundscape, as well as the average time spent in respective soundscape.

All the interaction lasted for more than 2 minutes and under 5 minutes. This is drastically higher than the brief interactions with the previous explorative soundscapes. While the time difference between the participants, this is also expected as they are acting from their own agency and internal cues when feeling done with the interaction. It can also be seen that each participant spent about the same with all three soundscapes in their own timing. Happiness was the soundscape the participants on average spent the most time with, it was also the most favorably spoken about in terms of pleasant perception.

5.5 Findings

Some important dimensions of the subjective experience were found through the user testing. These emerged through the analysis of the self-reporting materials, observation and interviews and are detailed below.

Associations and Imagery

When reporting on the experience, a naturally occurring way for all three participants to discuss their felt experiences was using association and imagery. Different types of scenes, images or situations were evoked between the participants and the soundscapes. While the soundscapes were based on their respective affective cores of Happiness, Sorrow and Fear, the felt experience of each varied between the participants. Scenes of running, exploring spaceships, hiding, crossing over a meadow and being part of a fantasy world are all examples of different reflections of the experiences with the soundscapes. The images conjured during interaction could be seen in the material noted down by the participants during the experience. These were
also used to recall the experience when remembering it in the post-testing interview and discussing it. The difference in experience of the soundscape’s points to a possibility for each to infuse the experience with individual perception and imagination, making it their own. For example: one of the participants connected parts of the experience of soundscapes of Sorrow to the feeling of walking in a forest without any explicit cues of a forest scenery. As the prototype lacked any visual type of stimuli, the sounds could have fostered imaginative and associative ways of coloring the experience, or as a means of anchoring it. To describe abstract experience, there also seems to be a need of de-abstraction to make sense of the experience in turn becoming a sort of storytelling.

**Emotional and Affective Dimensions**

While the aim of using the affective states as inspiration was never to replicate the exact experience of these for the participants, some of the reported feelings of them were still surprising. Using the affective cores as a mechanism of experience worked as somewhat of a thematic tool in the experience of them. *Happiness* was positively experienced by all, words such as “uplifting”, “dreamy”, “calming” and even “happy” being used to describe it. This also fostered visions of freedom and adventure in the way it was spoken around. This implies that the state of happiness also influenced the experience in such a way. *Sorrow* was described as feeling “careful”, “tentative” and “slow”, but also as “exciting” and “playful”. This could perhaps be linked to sorrow as an interpreted state being the most diffuse out of the three, making it resonate quite differently for different people. It seemed to foster the most reflective scenes out of the three and conjured descriptions of being cinematic and scenic from all participants. Finally, the soundscape of *Fear*. This soundscape garnered the most negative type of emotions, such as “creepy”, “stiff”, “annoying” and “scary”. But it was also described as “thrilling”, “exciting” and “fun”. Here, a strong sense of chase and mystery was described, and activities such as hiding, running, and escaping were used to illustrate the perceived action of the soundscape with comparisons made to thriller or horror movies. When looking at how the soundscapes were discuss and perceived by the participants, it seems to indicate that using affectively charged states different types of emotionally felt experiences could be facilitated. The abstract nature of them invited the participants to make sense of them in their own way, infusing the experience with individual interpretation and experience. Another element having an impact over how they were perceived is also the interaction itself affording certain types of behaviors. As indication for specific interaction weren’t clearly visible it could also have added to each of the soundscapes being experienced as “playful”, “fun” or “engaging”.

** Exploration**

Elements of physical exploration of the experience were observed in the way the participants approached and moved towards the prototype. There was a
noticeable learning curve that could be seen in the physical attitude towards the sensors. This was especially noticeable in the first soundscape, but even as the basic understanding for how to interact had been created the explorative approaches continued throughout the testing. Observed behavior consisted of stretching out arms, backing away to reset the sounds, jumping sliding and changing pace of movements. It looked like the possibilities for interaction and control of the sounds were explored and tested through each soundscape to figure out how to approach the interaction. One of the participants also extended this into their description of the experience describing it as “figuring out the controls inside of a spaceship”. This could also point to a certain amount of immersive sensation as the focus on the sound and movement made for an uninterrupted and involving experience. A re-occurring aim brought up by the participants was that of wanting to figure it out, both the sounds and the order in which they “should” be engaged with. This was expressed in the post-testing interview as well by one of the participants as they discussed trying to find the underlying and (perceived) correct way of assembling the sounds for the experience.

**Context**

As headphones were used this isolated the experience and removed the possibility to share it which had an impact on how it was interacted with. One participant expressed a desire for bigger speakers and being able to share what they were making, as they stated they were making a song when interacting with the *Happiness* soundscape. Another participant expressed feeling “dumb” and stopping themselves from fully entering the experience, implying a barrier between being able to fully immerse in the experience. This is also likely related to being knowingly observed during the interaction, which could have added a performative aspect to the interaction. Once again, as the use of headphones isolated the sounds the knowledge of being seen as moving in silence could also increase a sensation of feeling exposed. The context of experience is important, and it perhaps was not given sufficient attention in the set-up of the testing.

**Control**

In one of the soundscapes of each testing session, the casing for one of the sensors was changed from a standing one to a boxed-shaped one. This was differently received between the participants. One participant thought it elevated the experience as it added a dimension of interaction through direct manipulation of the sensor, using it to trigger sound by pointing it at the wall or floor or even themselves. Another participant however thought it was disturbing the flow of the experience as it forced the direct manipulation and effectively locked you too close to the sensors. For this feature to be more thoroughly examined, more space needs to be allowed for one to move with the sensor. As it was now, it was connected by wires no longer than 60cm making it somewhat difficult to combine with the other sensors. Still, aspects of it were positively received pointing to some value in the introduction of it.
There was a clear interactive breakdown brought up by one of the participants when interacting with Fear, where a dominant sound became repetitive and effectively drove her out of the experience as it became very annoying. While the soundscapes are more evolved than in the explorational phase, they are still limited in the current form. The issue of repetition is one to keep an eye on as it has a strong and mostly negative impact over the experience.

Finally, the ability to manipulate the low pass filter of part of the soundscape was not really noticed as a feature by any of the participants, it was too vague and unclear making it a pointless dimension in the interaction. This would need to be evolved further to be able to gather any information on.

6 Discussion

As stated by Buchenau & Suri (2000), to understand subjective qualities in interaction one needs to experience them. The live testing of the prototypes throughout this project was essential. Through the user testing, new insights were gained in the way the participants handled the interaction as well as in how it was spoken about during and after. Open and individually guided reflections around the experiences also allowed insight into the subjective sense-making of the prototypes.

Each of the three soundscapes elicited responses from the participants. When discussing their experience, both in text and the post-testing interview, some form of storytelling occurred with all three participants. This could be seen as a way for the abstraction placed in the soundscapes to be made less abstract. This tendency is pointed out by both Doherty & Doherty (2018) and Hassenzahl et al. (2013) as a way of communicating and consolidating subjective experience. Through the scenes and stories told by the participants of their interpretation of the experience, emotional dimensions were also tied in. Examples of this of the experiences being perceived as scary, uplifting, calm or tentative. As discussed in the Theory section (2.2), the role of emotion can be seen as central to the human experience (Forlizzi & Battarbee, 2004). The affectively aimed soundscapes managed to guide the theme of the experience but not completely control the emergence of the emotional dimensions in it. Instead, each sparked responses which seemed to exist within certain spans of emotion rather than in specifics. Participants shared common perceptions of general states in some of the soundscapes.

The individual interpretation and creation of experience also point to a success in facilitating subjectively formed experience. Through the abstraction of the soundscapes the space for the individual to interpretation increases creating a more immersive and connected experience.
Emotional response does not exist in a vacuum. It is dependent on multiple factors of both contextual, societal and experiential qualities (Boehner et al. 2005). This could be traced in the findings of the affective soundscapes prototyped in this project as well. While immersion can be facilitated through dimensions of design (Agrawal et al., 2019; Kitson et al., 2018), the actual space one inhabits while interacting does not necessarily completely fall away. The university building in which the testing was conducted, carry connotations of its own for example. Other factors include the awareness of being observed, the solitude in wearing the headphones, the lighting, the view. All of these were mentioned in different capacities by the participants and were not given all that much consideration in the design of the experience. In one of the tests another person passed by during the testing, further illustrating the dimension of the ongoing outside world. The connection between the experience and the space it inhabits is one of importance in this context.

When discussing experience prototyping, Buchenau & Suri (2000) note that the tools designers employ when prototyping also guide the way in which solutions and even imagination is formed. Throughout the design process of this thesis, the use of sound and ultrasonic distance sensors guided the process. Inevitably, the final prototype and experience is also shaped around these materials. Through the continuous exploration of this specific design space, a deeper understanding of the emergence of this specific type of experience could be formed. The basis of interaction was practically the same throughout all the three final soundscapes, and the way in which this impacted the felt experienced is also a dimension to consider. For example, the re-occurring ways of describing the soundscapes related to it being fun, enjoyable, or playful. The way into which the interaction was formed also encouraged free exploration of the soundscapes, perhaps guiding this perception of the soundscapes as well.

6.1 Research through design

The primary method chosen for this thesis was research through design as introduced by Zimmerman et al. (2007). As previously mentioned, part of this are the four lenses through which the conducted design work can be critically evaluated and reflected on. Below, these have been applied to this project to examine the outcome in a more objective manner.

The Process of this thesis has been clearly documented, from the initial explorative phase in Chapter 4 to the making and testing of a prototype in Chapter 5. The process could well be replicated, but as stated by Zimmerman et al. (2007), that does not necessarily mean that the same results can be produced as different designers bring different things to a process. The other methods used during the process has also been motivated and utilized in the process.
In terms of **Invention**, the context of exploring solely auditory dimension as the driving mechanism in interactive and emotionally geared experience seems to be less of an explored field in the research material acquired in this project. Often the sensory input of sound is either coupled to real-life surroundings or other means of sensory aspects. This could be indicative of some level of invention in the focus of this project.

**Relevance**, the preferred state this work strives for is towards design which embrace the inherent human ability to make sense of one’s own experience, designing for spaces which both allows and facilitates this type of multidimensional experience and personal interpretation. In extension, this is aimed towards richer relationships with technology and the way in which we can interact with it.

When looking on the **Extensibility** of this project, there is a lot of room to build on from the knowledge presented here. This work would work well as base to build from as there is much space to further extend the experience, both in terms of soundscapes, sensors and overall context that could bring the interaction in many different directions. This is also touched further on in the section 6.3 Self-critique and Future Work.

The use of research through design has helped shape the process and aim of the entire thesis. By allowing an explorative focus to emerge, a more open and embracing process could be conducted which I believe has been helpful in the treatment of the topic of emotion and affect in design.

### 6.2 Ethical Considerations

When embarking on designing for emotions and affect, it is important to consider the ethical implications of this. While using emotional influences as a means for meditation, self-reflection, enjoyment, or positive change are all well intended ambitions, nudging behaviors can also be used in manipulative and negative ways, causing distress or exploitations of users. While this project has not been focused on the measuring of emotional responses to a system, it is attempting to elicit an emotional response which can be intrusive and unethical if not treated carefully. As the subjective responses of people are a sum of their personal and private experiences, it is of high importance to respect boundaries of privacy, as well as being transparent around the process. One also needs to consider the intentions and implications the design could have for people in the real world.

### 6.3 Self-Critique and Future Work

The primary way of collecting information on subjective experience have been through an open approach to self-reporting, both by myself and the participants in the user test. While this might be representative to some extent, it is important to acknowledge that it can be problematic to use oneself in this capacity. This can create experiences that are biased and built on
unintentionally excluding principles. It is important to in any further capacity of this work enable more direct input from other people.

The participants of the user test were only three, making it a rather small testing group. All the participants were also around the same age (27-32), making it quite homogenous in that regard. As the subjectivity is a large part of this project, more diverse testing could perhaps have helped inform the design more.

In the set-up of the user testing, more attention could have been placed on the contextual factors of the experience. This extends both to the choice of using the open spaces at Malmö University, as well as the use of headphones which isolated the participants while interacting. Placing the experience in other contexts such as in complete darkness, outside, or in a more well-travelled and public place could yield different responses to the experience. With this, the placement and potential concealment of the sensors could also be experimented with more as they remained the same throughout all the testing sessions in this project.

The work conducted in this thesis could also be further extended on by supporting use by multiple users to explore social dimensions of emotional interaction. The interaction could also be further extended by introducing light, or even smell and touch. It would be interesting to see how the felt experience of sound would change when no longer being interacted with in isolation.

7 Conclusion

The work produced in this has been centered around the research question of:

*What does it take to create a type of sound-based interaction that evokes an emotional response?*

This has been approached through an initial explorative phase into the creation of interactive soundscapes. Using the findings in this exploration the three affectively inspired soundscapes of Happiness, Sorrow and Fear were constructed. The experience of these was examined through three user testing sessions.

As emotional dimension of experience is subjectively lived and felt, creating adequate space for personal interpretation is important. When employing design using sound as a sensory input, creating more abstract soundscapes which are open for personal interpretation is a way to encourage that type of experience. Through this, some levels of meaning-making and imaginative immersion can also be facilitated.
Designing for exact responses is not feasible as the way in which people construct experience is a sum of their own references and previous experience. Instead, emotional experience can possibly be guided within a span of emotions as indicated by the responses to the three affective soundscapes. In this composition is also important to be attentive to other contextual factor and how they can impact the responses and feelings in experience. When designing towards emotional responses it is necessary to be careful in how experience is constructed to not put any potential participant in an uncomfortable position.
8 References


