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SOUND PERCEPTION

Encapsulating Intangible Voice Memories in a
Physical Memento

Mona Makhlouf

Approval certificate for Mona Makhlouf for the thesis project entitled Sound Perception: Encapsulating intangible voice memories in a physical memento. Submitted to the faculty of the Master of Fine Arts in Design of Virginia Commonwealth University in Qatar in partial fulfillment for the degree, Master of Fine Arts in Design.

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ABSTRACT

We live in a very busy world with a variety of sensory stimulation including the olfactory, visual, tactile, and auditory. The five senses are triggered by our surroundings and help us to form meaning about the world.ⁱ Based on where someone grows up, she or he is introduced to various sites and sounds, affecting how they interpret the world. Sounds relate meaning through the association between hearing, memory and an event. Hearing is one of the learning processes, in which individuals give, receive, and store information. We typically rely on our five senses, which contribute to the process of understanding, communicating, and comprehending information. Moving beyond visual perception requires systematic attention to individual learning modalities.ⁱⁱ

Sound is one of the developing areas in the field of perception that moves beyond vision to help people understand nature, objects, narratives and varieties of perception. In order to comprehend how people hear, it is important to understand the role of perception. Sound functions as a signal, but also varies according to the capacity to hear. An individual's

physical ability to hear, and their unique experiences with sound, differ from one person to the next, and can result in a range of emotions and reactions. Certain sounds, like the voice of a loved one, also have the power to trigger emotion and convey meaning due to the association between hearing, memory and specific events from one's past

In short, the three aspects of sound perception—signal, hearing, and emotional reaction—play an integral role in auditory perception and the subjectivity of sound. However, the value of sound is often taken for granted or viewed as secondary to visual perception. This thesis will explore the value of sound perception by investigating two of its primary aspects—hearing and emotional response—in application to memory. Through a series of experiential objects, that trigger the senses. The aim is to utilize design to memorialize precious sounds in order to raise awareness about the emotional value of sound to the human experience.

1 BACKGROUND

1.1 Sound and hearing

From an early age, the ability to hear is one of the key factors that helps humans connect with one another and understand the world. The hearing process starts with the ear, which picks up sound waves and sends them to the brain in the form of neurological codes.

The brain decodes these and sends the information back to the auditory system, and the individual comprehends the auditory information given.ⁱⁱⁱ The brain is the center of this whole process.

1.2 How We Hear

The process of hearing has two primary aspects: the mechanical complex system of the ear and the neurological processing of the information developed.^{iv} The mechanism of hearing is simple and straightforward, however the brain's interpretation of what it hears is still a matter of dispute among researchers in the field of perception.

Hearing depends on a series of steps that involve changing sound waves in the air to electrical signals, in which our auditory nerve transmits to the brain, resulting in auditory processing and the ability to understand speech, sound and information.^v Sound waves enter the outer ear and travel through the ear canal, passing through the ear-drum, which vibrates and transmits those vibrations to small bones in the middle ear. This process is known as air conduction hearing. However, there is another method by which a person can hear, known as bone conduction. In this process bones transmit sound waves directly bypassing the eardrum and straight to the inner ear, allowing the person to hear through their bones.

The brain does not automatically have auditory information stored in its memory until it learns to associate sounds with a particular context.^{vi} Once an association is made between sound and context, a person comprehends the auditory information given. This phenomenon brings about questions regarding the subjectivity of sound and the role that sound perception plays in daily life.

1.3 Hearing Impairment

Hearing impairment is a disability that affects the process of hearing. An individual who is born in a muted world might perceive that world in a different manner than one who has never been hearing for all of his or her life.

Sensorineural hearing impairment changes how sound is perceived.^{vii} Those changes to perception are due to speech comprehension, and sound quality. Introducing sounds to an individual who hasn't been exposed to sounds and who is unaware of surrounding sound, can make it feel as though the brain is being programed from scratch. This process is called auditory processing.

According to *Egyptian Streets*, an independent online news magazine, each year In my home country Egypt, more than 130,000 Egyptian are born or diagnosed with profound to complete deafness.^{viii} These children are deprived of the ability to hear their surroundings, communicate verbally, hear music, or comprehend what they hear.

Growing up in a muted world, these children must rely only on 4 senses, often resulting in miscommunication or misperception of the surrounding world.

New technology has made it possible for children with severe hearing loss and profound deafness to learn about sounds around them and learn how to speak. A cochlear implant is an electronic device implanted in the skull, along with an external piece that helps pick up sound from the environment, transmit sound waves into codes the brain can process the information, whether it is speech, ambient sound or music.^{ix} This device can help a child hear for the first time and begin to engage with the world through sound. While it does not mean the patient will hear and understand the world in a complete manner, it is a lifeline for children who feel disconnected from environments rich with sound and meaning. When a cochlear implant is initially inserted, however, the new sounds can be bewildering and chaotic to a child who is hearing for the first time.

1.4 Learning Through Sound

The sound education process is essential to associate sound and context. During my interview with a cochlear implant surgeon, he explained that auditory comprehension involves one's pre-perceived knowledge of what one hears. I learned that this process develops in the early stages of childhood, contributing to the auditory/hearing development, cognition, speech production and language acquisition. The first three years of a child's life represent the period during which the brain is developing cognitively and sensorially. The ability to hear and communicate verbally are skills best developed when the child is exposed to a rich world of sounds, sights, speech, and other languages.

I learned from a speech therapist at a rehabilitation center in Qatar, that when hearing impaired patients first start using a cochlear implant, they go through an educational process that involves linguistic and auditory training to comprehend the meaning of the sounds they hear. The initial experience often involves exploring the world through a combination of visual, tactile and auditory senses. In addition, training starts from learning how to hear, followed by understanding sounds and communicating verbally. Auditory development is further broken down into four main steps in training: auditory awareness, discrimination, identification, and comprehension.

The incomprehensible sounds have no meaning unless they are associated with an action or an experience. The brain cannot process what it is hearing, if it was not trained to make meaning out of ubiquitous sounds. This phenomenon might be similar to an experience of being in a dark room that is filled with random sounds. The individual might not have an idea where the sounds are coming from or have the ability to perceive the sound, or comprehend the meaning unless those sounds are previously stored in one's own unique reservoir of accumulated experience, sound memories, and knowledge.

1.5 Sound Characteristics

Many factors go into hearing, including wave properties, sensory and brain processes. Sound is made out of sound waves, which have specific wavelengths and frequencies. Sound reaches the human ear, and is processed in various parts of the brain. We might assume that the brain deals with sound patterns in the same way it deals with visual patterns. If a pattern is repeated enough, we learn to recognize that pattern as belonging to a certain sound preserved in our auditory memory library. The process of interpreting the sound varies from one person to the other, by the ability of the sound quality heard and whether the sound is innate or learned.^x

2 SOUND PERCEPTION

2.1 Perception

Perception is the process by which we interpret the world around us. Perception is the act of comprehending data, but it is not clear exactly how we perceive that data. According to Casey O'Callaghan who wrote for *Stanford Encyclopedia of Philosophy*, due to the different theories in the field of philosophy and psychology, philosophers have predominantly focused on the perception of visual information.^{xi} The nature of perception and senses were discussed much earlier in history in Egypt, India, Greece and Rome.^{xii} Studies of perception, as it relates to psychology, were initiated by German doctor and psychologist Wilhelm Wundt, who founded the first psychology laboratory in 1879.

There are many definitions and theories of perception. Psychologists who delved into the study of perception include R.H Forgas who in his book *An Introduction to Psychology*, describe it as the process by which a person receives certain information about the environment. On the other hand, J.J Gibson, who is also a psychologist, argues that

sensations are occasional symptoms of perceptions, and not causes of it.^{xiii} The clearest theory is the notion that perception is the process of recognizing, gathering. Storing and interpreting sensory information. Each of these aspects contributes to the way that an individual perceives information.^{xiv}

Perception deals with human senses that create signals from the environment through activating the five senses: seeing, hearing, touching, smelling and tasting. Vision and hearing together are the best understood. However, there are some subtle differences between sensation and perception. Sensation is one of the essential aspects of perception. It is the awareness of, color, sound, taste, temperature etc. Professors of Philosophy Roberto Casati and Jerome Dokic wrote in *The Stanford Encyclopedia of Philosophy*, it is due to the sense-organs and interpretation of the meaning of that sensation, while perception involves selection of stimuli.^{xvi}

2.2 Sound Perception

Psychoacoustics is the study of the perception of sound. This includes how we listen, what we seek to better understand our perception of sound and our psychological responses to and the physiological impact of sound on our nervous system. The mechanical process of hearing is the beginning of our sound perception. Sound interpretation is poorly understood; in fact, it is not yet clear whether all people interpret sounds the same way.^{xvii} The only research method available to us to have people listen to sounds and describe what they have heard. The variable listening skills and vagueness of language, understood through sound, makes psychoacoustics a rather challenging field to study.

There are 3 aspects and dimensions to sound perception: signal, hearing, and emotional reaction.

2.3 Signal

The awareness of sound is the result of vibrations in the air. In order to have sound, there are two conditions that are required; vibratory disturbance and an elastic medium, the most common of which is air.^{xviii} The physical characteristics of the sound are factors including frequency, intensity, overtones. The human ear can respond to frequencies from 20Hz to 20kHz but has a peak of sensitivity around 4-3kHz. Sound characteristics; pitch, loudness, phase, direction, distance, and timbre form the perceptual experience of sound to the human ear.

2.4 Hearing

According to Casey O'Callaghan professor of philosophy at Washington university and Mathew Nudds head of the philosophy department at UCL in their book *The philosophy of sound and auditory perception*^{xix}; since it is plausible that sounds are perceived only through

the sense of hearing, sounds commonly are counted as proper senses of audition. Human hearing relies on the ability of the ear and neural system to sense and process the vibrations of the sound.^{xx} Several philosophers have argued that sounds are events of a certain kind. Casati and Dokic identified sounds not with the property of vibrating, but with the event of an object vibrating.^{xxi}

2.5 Emotional Reaction

In a TED talk Julian Treasure, a business sound expert, explains four ways sound affects our body: physiologically, psychologically, cognitively and behaviorally.^{xxii} Sounds are surrounding us all the time, and it is inevitable that they will affect our bodies and health. One of the ways sound affects our body is psychological; sudden loud sounds cause the body to go into fight mode releasing the hormone cortisol, affecting our breathing, heart rate and brainwaves.

While sounds affect our bodies, they also affect our mood. A good example of this is music. Music is the most powerful form of sound that affects our emotional state, but natural sounds—the waves of the sea or birds singing—also affect our mood and emotional state.

Treasure further explains how sound affects our body cognitively. We are third less productive as productive in an open-place office as in quiet room. The brain has a very small bandwidth for processing auditory information in a loud space and in a conversation between two people talking simultaneously. Unsurprisingly, the way sound affects our body plays a role in our behavioral shift. Thus whether sounds affect us psychologically, physiologically or cognitively, sound does have a powerful impact on our feelings and how it evokes emotions.

3 VOICE MEMORY

3.1 Memory

We tend to think of memory as a cupboard that restores events, experiences and thoughts, which we retrieve for later use. The article, “How Memory Works”, by Richard Mohs, explains that there are three stages of memory: encoding, storage, and retrieval.^{xxiii}

3.2 Voice as Memory

The ring tone of our first mobile phone, the voice of our late grandparent, or our newborn baby’s first cry are memories that make up the ongoing experience of life. They are what makes us feel comfortable or nostalgic; they are the catalyst between our past and our present. Mohs clarifies that memory does not exist the way a body part exists - it’s not a thing we can touch. Instead, memory is a concept that refers to the process of remembering. When we hear the voice of our loved ones, for example, or the sound of the ice-cream truck,

our brain retrieves the person’s face, the place where that event occurred, the smell that was present at that time and the feeling associated with that particular moment, everything that the brain created, experienced and stored during that moment in time. Each of these sensations traveled to the part of our brain called the hippocampus, which combines these perceptions as they are occurring into one single experience, your experience of the specific event.

“The creation of the memory begins with its perception. The registration of information during perception occurs in the brief sensory stage that usually lasts only a fraction of a second. It’s your sensory memory that allows a perception such as a visual pattern, a sound, or a touch to linger for a brief moment after the stimulation is over.” – Mohs

3.3 Emotional Memories

Most emotional memories, according to psychologists, are the result of a triggered memory. For example, a certain date may prompt emotions such as birthdays, graduations, or the anniversary of someone's pass. Anything that is connected to our senses may ignite emotional recall, Mary C Lamia writes.^{xxiv} Remembering events, situations, or a person can evoke excitement, anger, or grief. Emotional memory adds credibility to the notion that thoughts can trigger emotion just as the activation of emotion can create cognitions.^{xxv} In the same article "Emotional Memories", Lamia Writes:

Holding onto certain possessions may be a way to activate the recall of emotion. Yet it is not simply emotional memory that is triggered by an object but also the connection you had with the person who is represented by it.

3.4 Emotional Reaction to Voice

Emotional reaction to voice inputs differ person- to person depending on what one registers and what reaction and emotion are associated with the sounds we hear. Voice can affect us in so many ways, including psychologically. A verbal expression can change a person's mental state and mood, which usually comes with a set of emotions associated with a particular sound. The level of emotional connection and reaction differs from one person to the next. One can perceive the voice of a loved one as a precious moment. Another can perceive the giggles of their child as a beautiful memory that will eventually change. Memories are a way to remind the person of a particular moment in time, that brings joy, sorrow, or other emotions. Along with sights and smells, sounds have the ability to evoke emotionally charged memories.^{xxvi}

3.5 Sound Perception

There are 3 main dimensions to sound perception: sound itself (the signal), what each of us hear (our individual auditory sensation and what we register), and finally the emotions and reactions associated with the sounds we hear. Sounds in this case could be the memory of the endless crying of a first-born child, the laughter of a late grandfather or that tender “I love you” from a loved one. All those voice memories are stored in our auditory library, which can access during recall, however, we cannot hold a precious intangible memory physically, in our hands.

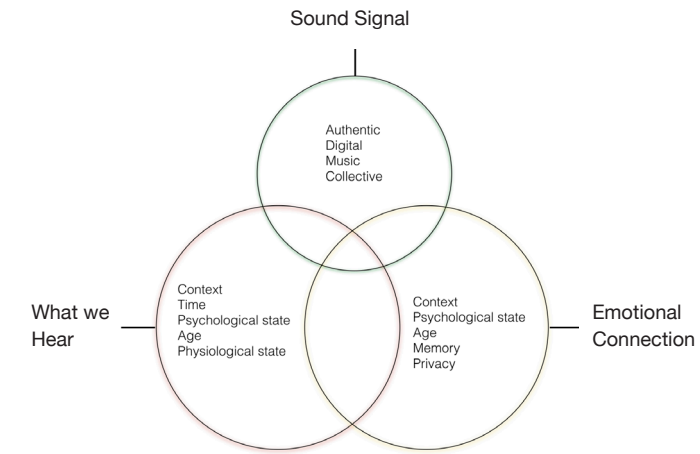


Figure 1: 3 Main Dimensions of Sound Perception

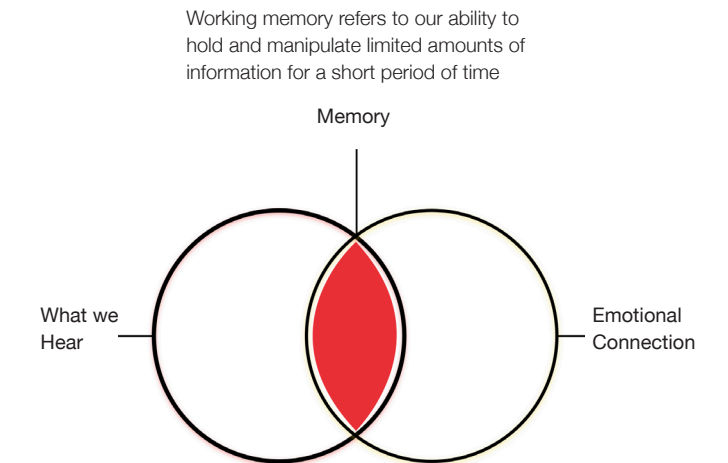


Figure 2: Auditory Library

4 PRECEDENTS: Voice/Speech memories and design objects

We do hear with our ears but we perceive the sounds we hear with our brains. The brain is the main center of sensory interpretation and processing whether it is visual, auditory or tactile. The same part of the brain that is in charge of processing our senses is also responsible, at least in part, for storing emotional memories. While we experience an event, the brain creates a memory, recording it and saving it for later use. That same recollection can be triggered by smelling a particular perfume of a loved one, where a graduation ceremony was held, or holding a childhood teddy bear. Hearing the voice of someone special can also trigger a powerful emotional memory. Objects are powerful tools to activate those memoirs, so does a voice memory. Voice memories can not be physically touched; however, they can be restored in a way. Traditional means of recording intangible recollections such as music or voices are on technological recordings, however, the value of that digital recorder might not mean much, versus a precious object such as a locket that holds a picture of a doted one.



Figure 3: Ruby Robin Boutique
www.ruby-robin-boutique.com

4.1 Wearable Memories

Emotional memories are powerful. According to psychologist Mary Lamia in her article, “Emotional Memories,” most emotional memories are the result of cued recall, but also, anything with a sensory connection can contain a cue that will trigger emotional recall. Holding on to a treasured possession can help one intentionally activate a chosen memory.

For instance, Ruby Robin Botique is an example of a handmade jewelry business that encapsulates the microcosm of forgotten memories in wearables such as necklaces (Figure 3) and rings. Each piece holds a precious story of pebbles collected from that special park, or sea shells from a favorite beach.

4.2 Voice Memories and Tangible Objects

“Build A Bear” workshop provides its visitors with the opportunity to customize their own bear and also to record a special message in a voice recorder box that is inserted in the toy, for the owner to “own the memory” and revisit it at any time. It is almost bringing an object with no soul to life (Figure 4). This girl pictured received a bear with the voice of her late grandfather embedded into it, which triggered tears the result of her attachment to her grandfather’s voice.

The memory of the voice of our loved ones, or the sound of our late grandparents, can evoke strong and lasting emotions. Preserving that precious auditory memory in a tangible object creates a more valuable memento. The items become precious because of the memory, embedded in the physical memento. The designed item, encapsulating that voice memory in an object, which can be triggered on demand, held and sensed by the person, leverages the power the power of emotional auditory memory so valuable.



Figure 4: Little girl receives a toy with their late grandfather's voice
<https://www.youtube.com/watch?v=kdB2qgdlw9A>.

4.3 Wearable For The Hearing Impaired

Since people afflicted with hearing impairment cannot experience sound the way other people do, there have been a number of projects that investigate other approaches to hearing impairment. One such project is a set of jewelry-like devices, designed by Liron Gino, which allows deaf and hard-of-hearing people to experience music through vibrations.



Figure 5: Vibeat
<https://static.dezeen.com>



Figure 6: Vibeat
<https://static.dezeen.com>

“Each wearable reacts to different frequencies to make the devices vibrate (Figure 6-5) at different rates” allowing the deaf person to experience music. This is a great example of why we don’t hear with our ears, but we hear with our brains, hearts, body and skin. A jewelry like device that allows the user to always have access to music, and carry it everywhere. The jewelry becomes more of a catalyst listening to music, rather than a fashion accessory.

4.4 Emotional Sounds and Installation Design

Researchers have also demonstrated that the auditory, visual and olfactory cortices each store memories related to the specific senses they process. Artist Markus Kison worked this notion of emotional sounds and how we hear into his installation “Touched Echo” (Figure 7-8)

This installation utilized bone conduction technology, which is another way we hear. In this process, the vibration of the sound waves are heard directly by the inner ear and surpassing the eardrum. This is how we hear our voice and also how whales hear.

Bone conduction was the technology used in “Echo Touched”, inviting visitors to become performers. The visitors are taken back in time to the terrible air strike in WWII. The visitors are able to relive the experience of those who have covered their ears during the airstrike, by pressing against the metal fence they are able to hear the sound that is transmitted through their arms, and directly to their inner ears.



Figure 7: Touched Echo
http://www.markuskison.de/touched_echo.html.



Figure 8: Touched Echo
http://www.markuskison.de/touched_echo.html.

5 EARLY INVESTIGATIONS

5.1 Mother's Voice: Home away from home

I come from a city that is always busy with noise, traffic, and people's activities on the streets. Growing up in Cairo stimulated and conditioned my senses and allowed me to always be attentive to ambient sounds and activities going on around me. Street vendors selling tomatoes, using their chants to attract people, car honks that never stop, the call to prayer that echoes from each mosque all in the same minute, and my mother's voice calling me to answer the door. Hearing those sounds on a daily basis built a sense of attachment to the city. Moving to Qatar was a new experience for me, it is a totally different than where I come from. I no longer hear the street vendors, the hustle and bustle of cars, the call to prayer echoing from each mosque, not even birds like I used to hear back home. Doha has a different auditory identity than Cairo, it's much more still and quiet.

I began to notice silence, and acclimate to an unfamiliar place. My ears were trying to pick up familiar sounds, but my brain and heart were still feeling homesick. To get me through this transition, I made sure I keep in touch with home, and connected with my mother on a daily basis through facetime and skype. Connection to me was not only texting, but also seeing her face and hearing her voice. Hearing her voice definitely provided me with a sense of security and comfort. This experience of a phone call with my mother triggered my urge to pursue something beyond a virtual call, which only remained in my memory. I was seeking something physically solid, that I could have at all times and would allow me to connect with her on a personal level. In my early investigations into the topic of emotional sounds, I began researching about sound and its effect on our emotional state, which led me to explore the overlap of voices, memory and emotions.

I was able to explore the notion of voice memory, working to translate intangible sensory experience into a tangible object. Voices we hear are usually stored in our memories, and

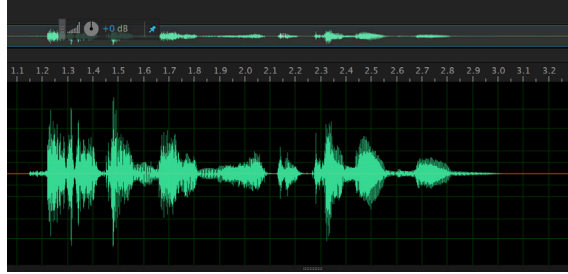


Figure 9: "Mother Daughter" Soundwaves

the process of recalling them again from our auditory library is up to the individual. Nevertheless, it will always be an intangible distant memory unless this particular voice is digitally recorded, where it can be played again. I took advantage of the technology by digitally recording my mother's voice (Figure 9) during an intimate conversation.

However, I was left with a digital file with soundwaves (Figure 9). After all, sound is a vibration that spreads as a typically audible mechanical wave of pressure. The fact that- technically speaking- her voice is nothing but sound waves to others, but to me very precious, caused me to question how design and technology can enhance the preciousness of an intangible medium in

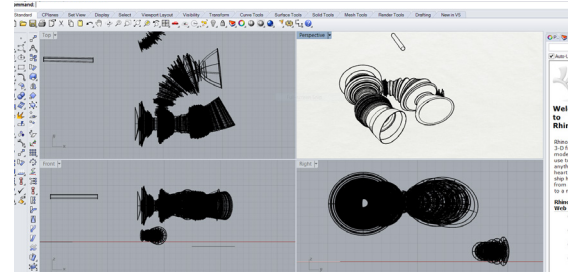


Figure 10: 3D modeling the voice

a physical form. Through digital fabrication, I was able to transform her voice sound wave lines into a 3d form using 3d modeling software (Figure 10). This led me to translate her 2d voice into a 3d mode, using 3d printers and PLA plastic.

The result is a speculative object for personal comfort (Figure 11-12). Our voices are translated and intertwined into a cornet that transmits a tender whisper to the listener. The personal mother, daughter voice conversation was captured, in the form of the artefact, and was inspired by that intimate whisper of the seashell against one's ears, recalling the sound of sea waves.



Figure 11: Mother Daughter 3D printed voices



Figure 12: Mother Daughter 3D printed voices

5.2 Physicality Of Sound: It’s Not What You Say It’s How You Say It

My fascination with music, sounds, and voices heard in our daily lives led me to study more about what sound can offer and communicate. In order for me to study sound, I had to investigate the notion of silence. Through my research I began to learn more about people who cannot hear, and was attracted to the community of hearing impairment. Picture this; you are born in a muted world, cannot hear your mother’s tender voice, nor can you speak back and let her know you love her too. According to the World Health Organization, 5% of the world’s population has disabling hearing loss and of these 350 million people, 32 million are children who suffer from hearing impairment.^{xxxii}

Many children are born unable to hear and verbally communicate. With the aid of technology, in some cases they are able to receive a hearing aid or a cochlear implant. Until they are able to restore their hearing, they rely on other senses: sight, taste, smell and touch.

All those senses collectively form the way we communicate, process given information, learn, and explore the world. Through my study of children who are born deaf and receive a cochlear implant, I was able to explore the means to express sound without actually hearing sound.

Research has proven the effect of speech, music, ambient sounds, and also voices can have a significant impact on our body psychologically and physiologically. The tone of our speech projects our emotions and also adds to our communication with others. The way a mother speaks to her children when she wants to teach them a tough lesson is different than her tone when she shows affection. The way we speak can also give misleading impressions. Body language, tonality, volume, eye contact, and facial expressions influence how we perceive information. Individuals with hearing impairment rely on these non-auditory cues to read what a person is trying to say.

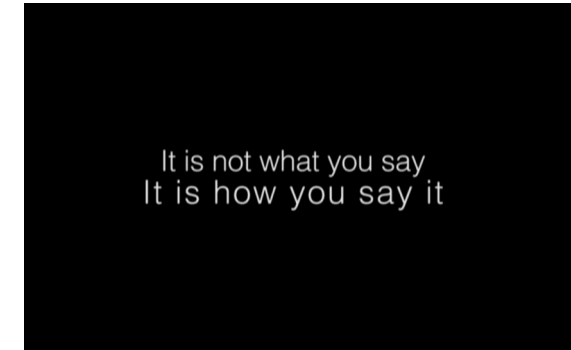


Figure 13: Still footage from the video "It's not what you say, it is how you say it. Refer to <https://vimeo.com/213430935>

There is a common phrase that goes: "it's not what you say, it's how you can say it." For instance, a simple "hello" with a poker face, fast pace, low pitch and deep tone can give an impression of anger. On the other hand, the same "hello" said with a smile a high pitch, and a slow pace, might communicate that the person saying it is having a great day and is happy.

For those who are able to read body language and facial expressions but are not able to hear, it can be difficult to understand what exactly a person is trying to say. Through my experiments, I explored the notion of communication taking into consideration another party's inability to hear. In my investigations I wanted to explore sound without a mediated interpretation of sound itself. As a design response, my intention is to invite people to listen with their eyes and not just with their ears, through a series of experiments, working with the physicality of sound. I recorded one sentence in Arabic said with different emotional expressions, tonality, and volume - once in a sweet way, and another in an angry manner.

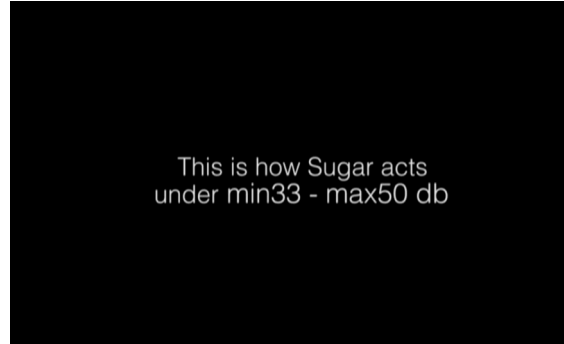


Figure 14: Still footage from the video "It's not what you say, it is how you say it"

Communication is not only limited, to verbal language, there are also cultural sounds and auditory expressions that project emotions. Expanding on this notion I explored what the sounds of laughter and Arabic yodeling sounds like, using sound vibrations to express sound visually. The results were physical visual interpretations of projected sound vibrations (Figure 11) with different emotional impressions. The physicality of sound was translated using rice (Figure 10) and seeds on a sub speaker. The sound vibrations choreograph the way those small particles moves, allowing the viewer to see how voice expressions differ from one to the other.

The experiment was done with 4 different records, under the range of 30-52 decibel.

- Laughter
- Yodeling
- Arabic أبجد هوز حطي كلمن سعفص قرشت abjad is mnemonic abecedarian sentence which corresponds to the numerical value of the abjad writing system, spoken with anger and affection.



Figure 15: Testing the physicality of sound



Figure 16: Plastic Grains



Figure 17: Rice



Figure 18: Sugar

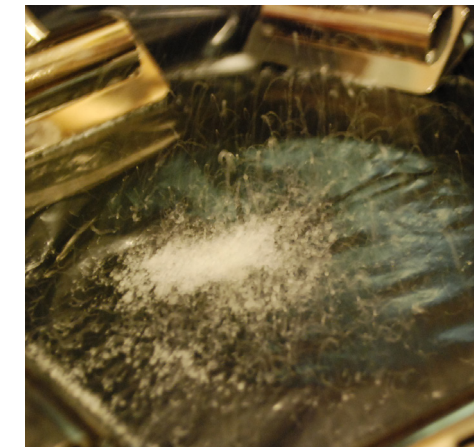


Figure 19: Yodeling min-38max51db



Figure 20: Laughter min-33max50db

5.3 Sound Perception: Sound Sound and Virtual Reality

The next phase of the research involved personally interpreting, researching and exploring the design possibilities of the notion of “Sound Sound.” In this project the expression “Sound Sound” is meant as “healthy sound”, which triggered my curiosity to question, whether all sounds are healthy sounds. Through my research on the effects of sound on the body, I learned that each person reacts differently to different sounds, whether noises, voices or music. Music, sound, and voices are all subjective to one’s own unique reservoir of feelings associated with certain events and experiences, hence sound perception.

Construction sounds are disturbing and unwanted to some, but they can be benign to the construction worker. The humming of the Air Conditioner can be irritating to a father, but very soothing to a son, who might even sleep while hearing the humming of the unit. This phenomenon raises the question of what is considered “Healthy sound”. Sound is

subjective to one’s own interpretation and is a language on its own. It can trick us, transport us geographically, and change our mood.

At the same time, just because something has a subjective side, does not mean it does not also have an objective reality. In other words, two people can hear the typing of a person on a keyboard, when asked what they heard, say “keyboard typing”, and even describe it. But when they describe the sound of the typing, certain senses react, based on each person’s stored memory of when they heard the ‘clickety clack’ of the keyboard. The subjectivity of the emotions associated with this particular auditory expression, mediates one’s experience of “keyboard typing”. Personally I find the ‘clickety clack’ sound of the keyboard typing to be soothing and playful. At the same time, it reminds me of that old typewriter that my aunt used to own, which I loved to pretend I was playing like piano. I would start pressing each letter and imagine a sound.

The sounds and voices we hear on a daily basis are stored in our own auditory reservoir. The way we learn about the meaning of any given sound is by associating it with a certain context saved in our memory. This project attempted to tap into this notion of sound perception by experimenting with sound associations. To do this, I played the sound of a bullfrog and asked the audience to write what they heard. Each person had a totally different interpretation, not even close to the original sound. The only person who was able to identify the sound was someone who grew up near a lake, where he often heard frogs.

The findings from the “Sound Sound” bullfrog experiment expanded my understanding and interest in the power of sound perception, in which my main thesis exploration derived. Whether we all react equally to the same sound or not, we all have unique perception. My goal was to continue to investigate the subjectivity of sound.

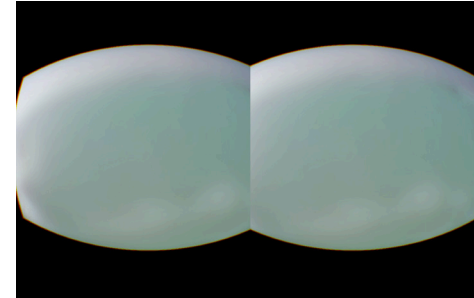


Figure 21: Beginning of the experience

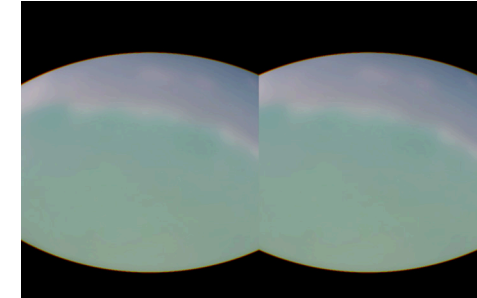


Figure 22

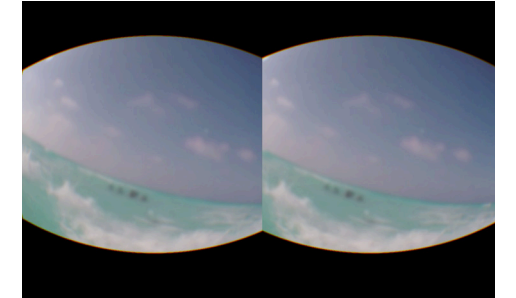


Figure 23

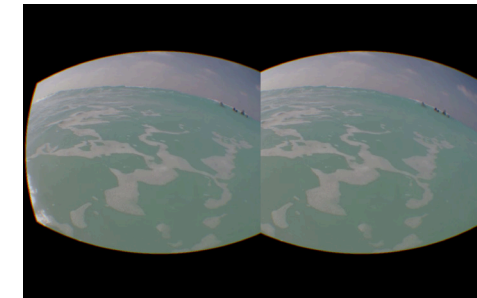


Figure 24: End of the experience



Figure 25: Hacking Google cardboard

Figures 21 - 24: Still footage from the video “Sound Sound”

My next exploration into sound subjectivity involved virtual reality as a vehicle to explore the subject of sound perception. While sound is a very powerful element in the field of perception, the visual also plays a role in the way information is received by the viewer. To explore this concept further, I recorded a single track of sea waves and accompanying visuals of sea waves, but distorted the quality of both sound and image (Figure 21-24). In an effort to create a seamless experience, I used google cardboard and headphones (Figure 26-27) as tools to help eliminate other sensory distraction. By limiting the field of vision and audition, the viewer travels on a virtual journey of stimulated senses and triggered emotions.



Figure 26: Mobile phone playing VR video through Google Cardboard



Figure 27: Experiencing Virtual Reality

“Sound Sound VR experience” is an audio visual piece which starts with an elongated distorted sound of sea waves with a blurred visual of the sea. The viewer gets to experience different sound quality of the same thing, which offers a different experience interpretation of what it is played. Little by little, the actual sound and image gets revealed. Refer to <https://vimeo.com/210742307> to view the video.

6 THESIS DESIGN AND IMPLEMENTATION

Having conducted primary and secondary research, I have gained an extensive amount of knowledge and information about the hearing process, and communication. I started to understand my perception and the perception of cochlear implant recipients and how perception plays a role in sound. It occurred to me that at a certain point we all share different perception of sound; due to one's history, past events, experiences and memories. This conclusion led me to my main thesis direction, in which I studied sound perception. The 3 categories of perception-internal perception, external or sensory, and mixed internal and external perception-played a role in the evolution of the design direction. More specifically, the thesis project explores the value of sound perception by investigating two of its primary aspects – hearing, and emotional response in application to memory. With a focus on the treasured voice memory of someone dear, the sound of a precious voice becomes an intangible memory; however, it holds a very intimate value perceived by the memory owner.

6.1 Understanding Emotional Attachment: Informal Survey

As part of my investigation to better understand the nature of preciousness in the context of personal possessions, and to better understand how various types of materials affect emotional attachment to possessions, I conducted an informal survey. I asked friends and acquaintances about objects and artifacts to which they feel emotionally attached, especially ones significant to them because they recall a specific incident or past moment. I was interested to know the story behind each item.

One participant shared the story of her emotional attachment to a pair of blankets.

“When we buried our son after suffering a miscarriage. There was a torn piece of cloth they used to shroud him. The second is a hospital blanket used to wrap my still born daughter.”

Another man shared story about a prized 20 EGP note.

“Every visit my grandmother always got us or gave us something. She forgot to get something and so she gave me and my brother 20 EGP note. I never spent it because she passed away a month after.”

Results of the survey suggested that people develop intimate attachment to items, not because of the materials they are made from, nor the monetary value. In the stories I collected, the emotional attachment was due to life events associated the artifacts, and the person who gave them. The key to the preciousness of items people described was the connection those items represented with the people and/or events associated with the object in question.

All of the stories are contained in the appendix.

6.2 Precious Artifacts and Emotional Memories

I once met a woman who told me she still holds onto a phone she got years ago, because it holds an old message from her grandparents. She took the outdated phone with her, even when she moved, and even though she no longer used it to call people. Her outdated phone became a valued possession, because it memorialized her connection to the voices of beloved people, now gone from her life. My goal for this project was to capture a voice memory in a solid form, but one designed to accentuate the memory’s potency.

Holding on to a treasured possession can help people intentionally activate a chosen memory. Awareness of this information allowed me to see the connection between voice memories, treasured items, and emotional attachment. In developing the design outcomes, I sought to utilize design to memorialize intangible memories in a physical form. Because sound is easy to capture and retrieve on command, as opposed to other sensory experiences, I focused on designing artifacts capable of storing voice memories.

Through my research, I was seeking ways to record voices and retrieve them on command. The most common way is digital recording, utilizing smart phones or a voice recorder. However, my objective is to embed the voice in a portable personal object, where the designed artifact serves as a “memory guardian,” honoring and protecting something that is no longer there.

6.3 Explorations: Memorializing Voice Memories in a Physical Memento

As a designer, I tend to observe behaviors and collect personal stories, drawing on my experiences to inform future design outcomes. Recently, after a busy day at school, I went home to get some sleep, exhausted. Once there, hours passed, and yet I was still wide awake. Everything I experienced that day cycled vividly through my mind, my brain racing through memories and unproductive thoughts. I was unable to rest until, unconsciously, I began to

think of home, to imagine my mother’s voice playing in my head, to remember her comforting me in times past. This thought, finally, relaxed me, and I drifted off to sleep.

The search for ways to physically manifest intangible voice memories led me to address two initial problems. First, I began to investigate a means of recording and saving voice messages, however having a digital recording of a voice was not sufficient enough, I sought more than just a recording. I was seeking emotional connection through a solid form that is both exclusive and accessible to the memory owner. In an effort to create an intimate listening experience for the user of the artifact, a “do it yourself” approach to technology was successfully embedded in the design of the artifact, through bone conduction.

6.4 Process and Fabrication

The decision to utilize the bone conduction mechanism intensifies the listening experience, and reinforces the intimate nature of voice memory. Anyone who interacts with the object can experience the preciousness of the message, because it's not audible to anyone but the person using it.

In an attempt to successfully encapsulate voice memory embodied in a cherished object I experimented with different bone conduction “do it yourself” mechanisms through hacking earphones and other electronic components (Figure 28). Through hacking earphones and a DC motor I was able to listen to digital recordings, by biting on the tip of the motor (Figure 29). Because the sound vibrations travel through the bones of the skull, only the user can hear the sound playing inside their head.



Figure 28: Hacking earphones

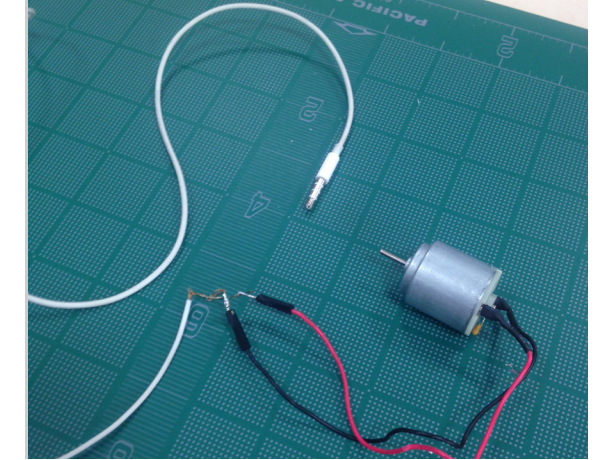


Figure 29: DC motor (Bone conduction)



Figure 30: Piezo Buzzer (Bone conduction)

Other mechanisms I experimented with to generate sound include the sound transducer, in which sound vibration when it contact any flat surface (Figure 34), turning anything into a speaker. My aim is to have a personal experience through the interaction with the artifact. I tested recordings of music and speech. The speech recordings generated by the sound transducer I discovered, have a beautiful soft whisper-like quality, which compliments the concept of my design.

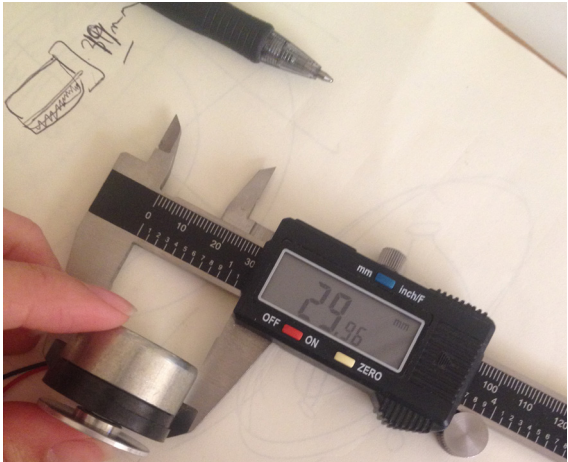


Figure 31: Measuring the Sound transducer



Figure 32: Soldering work and hacking the jack



Figure 33



Figure 34: Sound transducer + mp3

6.5 Early Sketches and Prototypes

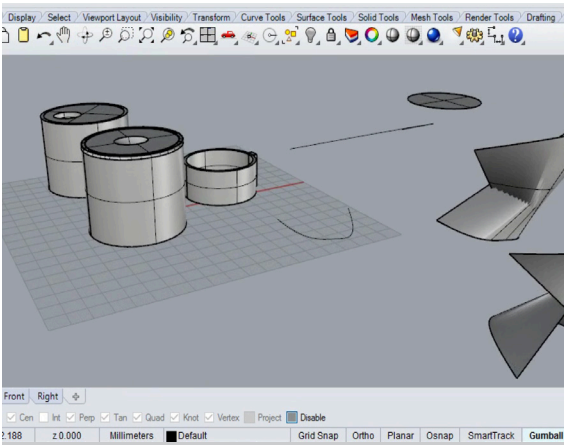


Figure 35: Artifact prototypes



Figure 36: Early prototype 3d print Casing



Figure 37: Process

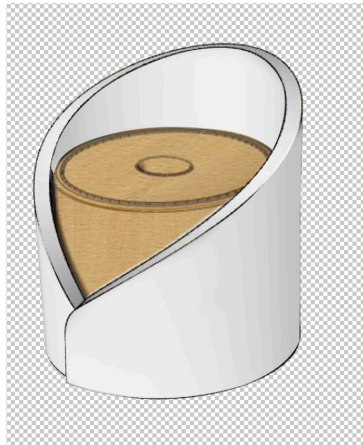


Figure 38: Design Prototype

Through designing the object, my aim is to deliver an easy system for the user to interact with the cherished artifact, while considering the intimate nature of the whole listening experience. The closer the user comes in contact with the object, the more personal the experience gets. That was my main goal to project the tenderness and preciousness of the memory through the use of materials, shape and mobility. Those design components informed the final form, and created the choreography, inviting the user to experience a precious moment. Using 3d software modeling (Figure 20), I sketched the different ideas to best reach my goal.

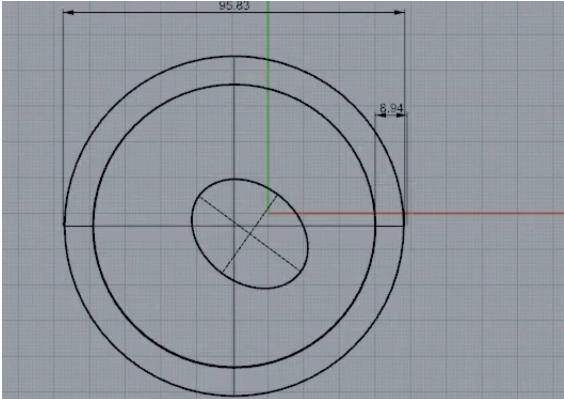


Figure 39: 3d modeling on Rhino software

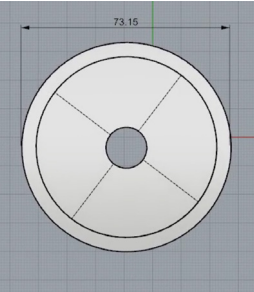


Figure 40: Modeling the Base

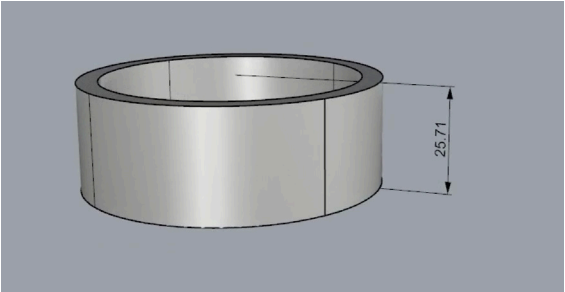


Figure 41: Modeling the Base



Figure 42: Preparing the wood
Photo courtesy of Haya Daher



Figure 43: Base CNC Milled

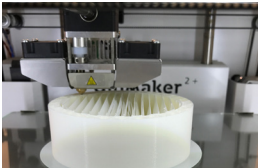


Figure 44: 3d printing tests

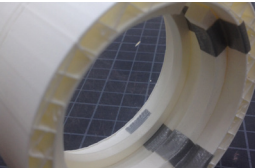


Figure 45: 3d printing liner test



Figure 46: CNC milling Walnut wood test



Figure 47: Base Pre Sanding



Figure 48: Gluing walnut wood blocks

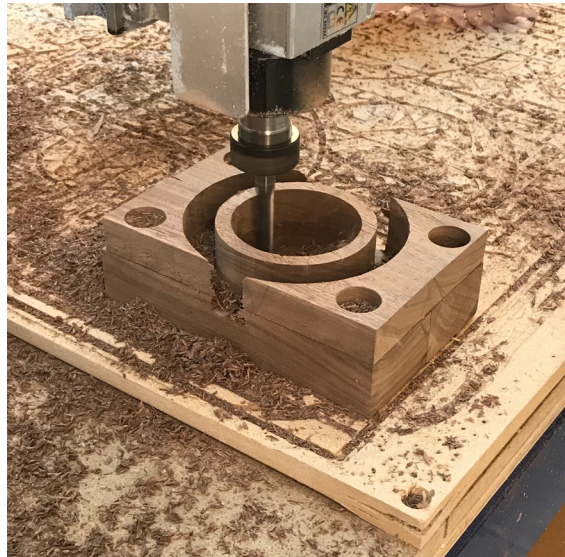


Figure 49: CNC milling cap



Figure 50: Pre Sanding



Figure 51: Using the Dremel to carve the finger indentation



Figure 52: Finger Indentation before sanding

The decision to use wood for the designed artifact, is due to the natural characteristics of wood. Also wood grains compliment the notion of time and memory, as wood ages beautifully. The form of the artifact is informed by the limits of the used technology yet; it supports the practicality and functional aspect of the object.

The final designed artifact is meant to be present in times of despair, or longing to connect with the person represented in the artifact. “Memory Whisperer” is a designed artifact that can be placed on a nightstand or working desk, in which the memory owner can easily trigger to experience that precious voice. By using technology to restore a voice recording, and sound transducer (Figure 50) to whisper the voice memory, when it comes in contact with a flat surface. I was able to memorialize the precious voice memory in a physical item.

Walnut Wood



Pine Wood





Figure 53: Final outcome “Memory Whisperer”
Sherine Karawya listening to the memory

6.4 Exploration: Wearable Voice Memories

The second exploration of this thesis was inspired by observing people and myself, during moments of reflections. During these moments, I get isolated in my poetic thoughts and start to daydream. During car and taxi rides, I often find myself drifting away in my thoughts, gazing at people driving their cars. Some are enjoying a family picnic on the corniche, while others are just taking a stroll along the street. Those visually perceived moments triggered my recollection of my home in Egypt, a place that I am longing for.

Through my research I learned that people get emotionally connected to objects. I looked into wearables and was inspired by lockets that hold a personal picture of a loved one. By preserving a visual memory in a keepsake pendant like form, people are able to keep the memory close to their hearts and wear the object wherever they go. This idea of a keepsake inspired me to design a wearable item that cherishes a sound moment and brings comfort to the memory owner. The act of leaning my head against the window when I travel triggered me to use this moment of reflection to embed the voice memory in an item. The goal was to retain a voice memory in the wearable item that can be recalled by the memory owner in times of need.

6.4.1 Process and Fabrication



Figure 54: Piezo buzzer embedded in the design of the scarf



Figure 55: Draping to test for accuracy

6.4.2 Early Sketches and Prototypes

We tend to have items that are important to us, whether a necklace, charm bracelet or even our mobile phone. In a Middle Eastern context, a scarf seemed to be the most culturally appropriate element in terms of its ability to convey comfort. Therefore, this exploration consisted of two elements, the bone conduction and the material of the scarf. The memory owner can experience the emotional memory by leaning their head against the smooth texture of the fabric and trigger the piezo buzzer by putting minor pressure on designated area. The comfort and softness of the material of the scarf, adds to the same feeling that the voice memory conveys. I created several prototypes to utilize design and visual triggers on the scarf to indicate where to place the part of the scarf to listen to the memory.

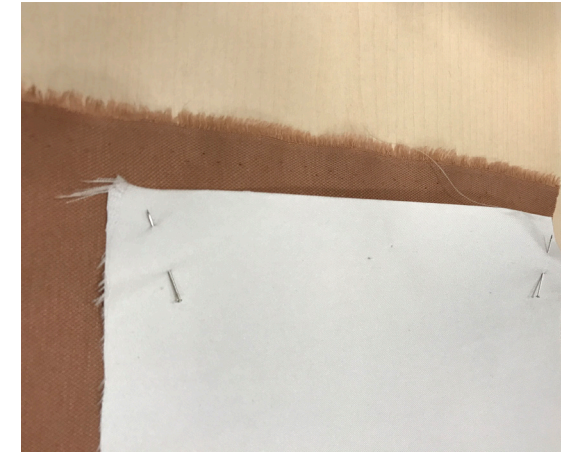


Figure 56: Early scarf prototype



Figure 57: Early scarf prototypes

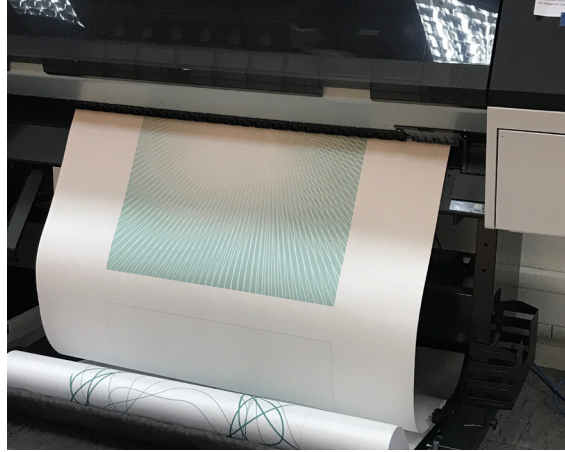


Figure 58: Printing on fabric

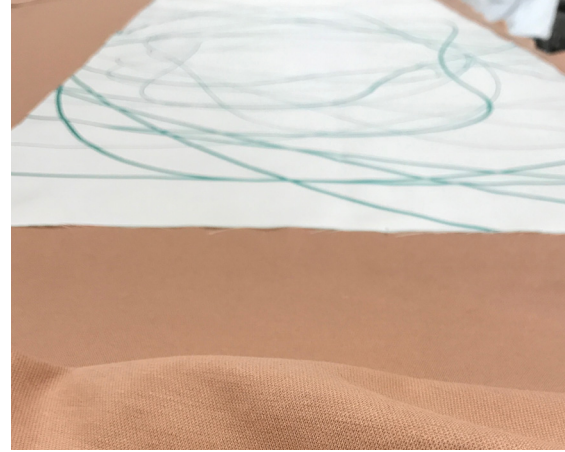


Figure 59: Making of the scarf, layering 2 fabrics

The final design combines the comfort of a scarf with the technology of bone conduction to celebrate the intimate nature of a sound memory. A hidden wire with a piezo buzzer is embedded in the scarf to generate sound through the bones of the skull combined with a portable mp3 as the input (Figure 54). The scarf is designed in a way that the piezo buzzer can be on the left ear and also on the right, according to the personal preference of the user. This design feature prompts the memory owner to flexibly and comfortably wear “Thread of Memories” scarf and secretly experience the voice memory through their jawbones.

Figure 60: Thread of Memories showing the bone conduction piece
Elena Teranova experiencing the voice memory using bone conduction

Figure 61: Thread of Memories

6.5 Explorations: Voice Memory as a Physical Form

Having explored the possibility of encapsulating voice memories in a physical tangible form, I explored the option of looking into the actual sound. The aim was to translate 2D wave lengths into 3-dimensional form to reinforce the poetic value of the memory. The exploration was inspired by an Arabic saying *حوته حلقه فودنك* that translates “Have this advice act like an earring, and always carry it with you.” In response, I developed a pendant to help people engage with a cherished and intangible voice memory as a physical item that is worn by the memory owner.

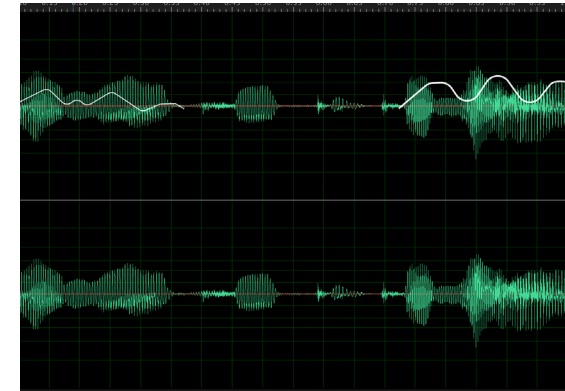


Figure 62: Voice waves

6.5.1 Process and Fabrication

Expanding on the early investigation of 3D printed voice, I used 3D modeling software and 3D printing technology to develop the pendant. The goal was to take an intangible voice memory from a sound wave (Figure 62) and translate it into a physical item that can be worn. Utilizing 3D technology (Figure 65-63). I captured the voice memory sound waves and transformed those waves to a physical representation. The pendant became a visual translation of that voice memory.

6.5.2 Early Sketches and Prototypes

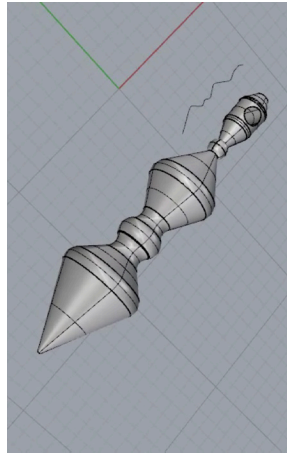


Figure 63: 3D modeling voice

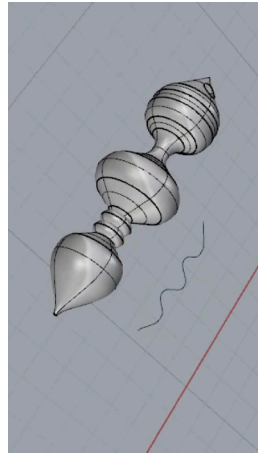


Figure 64: 3D modeling voice

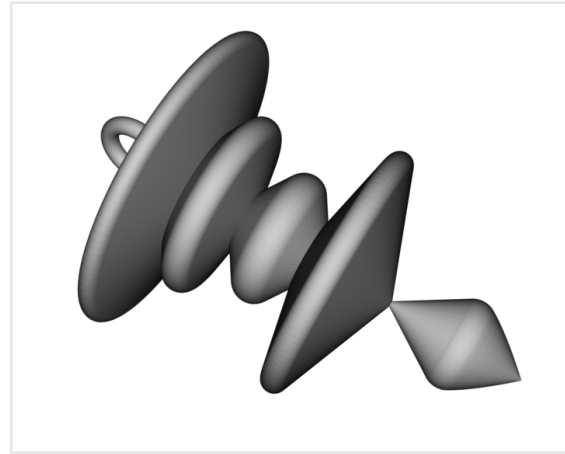


Figure 65: 3D modeling Voice Render



Figure 66: Stainless steel



Figure 67: Raw brass

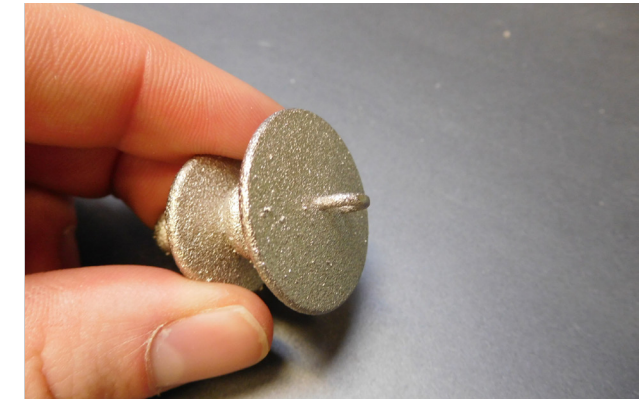


Figure 68: Polished nickel

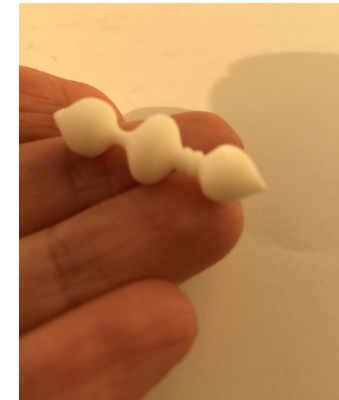


Figure 69: Flexible plastic

The final outcome of this exploration was a set of jewelry pieces printed using different materials (Figure 66-69) in order to reflect the intensity of the emotional voice memory. The materials of each pendant indicate the preciousness of the voice message emotions, while the roughness of a material shows the roughness of the voice memory content. Taken together, the pendant becomes a sentimental token of an intimate moment, translated into a physical form.



Figure 70: "I carry your voice" pendant - Raw brass

7 CONCLUSION AND FUTURE DIRECTIONS

At this point of my research I gained a solid understanding of ways to memorialize a past moment and keeping it forever in embodied in a physical form. I have established a foundation of sound perception in psychology and its relation to memory and emotions.

Memories are an inevitable part of life, whether the memory evokes positive or negative past experiences. They can be triggered by anything that connects with our senses, be it a picture, a smell, and object or a sound. Memories are also intangible moments in life that each one of us perceives differently than others. There are many ways to freeze a moment and preserve a memory; the most common one is capturing a moment through a photograph. The emotional attachment of people to objects is because it recalls a moment that evokes particular feelings.

Through the process of creating the experiential designed objects, I realized that it is not the object itself that contains emotional memory, but instead, the emotional memory is

triggered by the attachment and connection with a significant person tied to the precious object. Utilizing design as a vehicle to encapsulate an intangible memory in a physical object creates an opportunity to cherish that experience forever. Preserving voice memories or forgotten moments within designed artifacts offers new opportunities for sound to play a role in memorialized objects. Moreover, I see this project expanding in several directions, focusing on forgotten memories and past events taken for granted in history and daily lives in relation to social justice. I see a great potential to expand my research by commemorating “Sound of Cities” highlighting the infrastructure of cities and villages, and documenting the auditory cultures of people in places.

Citation

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Appendix 1

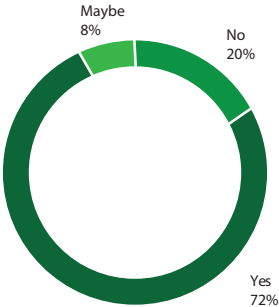
Informat Survey:
Q1: What object/artifact/item are you emotionally attached to, due to a signifant incident or precious moment that you have through? (this item can be related to a loved one a trip youn took or an important moment in your life or your country)

- Jewelry/accessories:** Bracelet - Pendant - Necklace - Wedding riing - A watch - keychain
Stress beads (Sebha) - Suit Pin
Paper based items: Quran - Old Photos - 20LE note - Old childhood drawings - Poster
Soft/stuffed items: Blankets - Teddy Bear - Bunny
Spaces: Bedroom - Rome - Agami

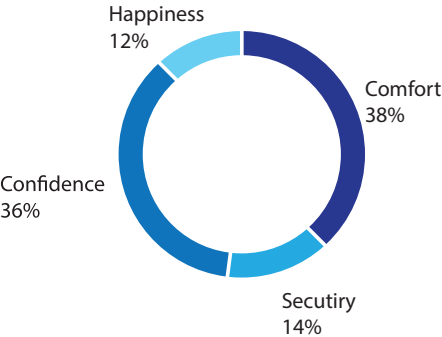
Q2: Where do you keep this item?

- Categories:
Wear it
Next to the bed
In the bag
In the pocket
On the wall
In my wardrobe
Electronic copy on my mobile
In my heart
Wallet
Keep it always beside me every where

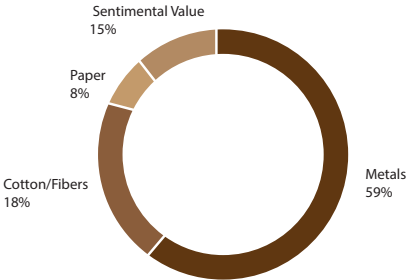
Q3: Did someone give it to you?



Q4: How does this item affect you? it makes me feel...



Q5: What material is the item made of?



Q6: Describe in few words the story behind this significant moment/event when you got this item?

The saddest moment.

Pleasant

I was visiting the Acropolis, and afterwards walked passed a silver shop where I saw it and fell instantly in love. I didn't buy it right away but couldn't stop thinking about it. I went to other stores but knew I had to go back, but we didn't know where the store was and I kept going back to every street and store until I found it, purchased it, put it on and never took it off in almost 4 years

I got the item on my birthday from a beloved one

When we buried our son after suffering a miscarriage. This was a torn piece of cloth they used to shroud him. The second is a hospital blanket used to wrap my stillborn daughter.

My birthday was near and my sister used to be my only best friend and I love the yin and yung symbol so she made it for me (not just bought a ready one) and she took half... it was along with another one engraved in it kind words and her signature but time los it...

Every time I did good on my exams I got a new Barbie and when I finish my exams I go to agami

I cannot remember where I got this item! It may have been a gift? I think it came from a shop in London. I'm fond of it because of my interest in ancient history and it's symbolic of Athena, the goddess of cunning and wisdom.

Its the place i find my freedom and my comfort

I found a wallet that i loved and then spent months looking for it until i found it and got it

Just was given to me

The only thing can understand and can effect on me

I collected it from a park where I used to run. The section of my run when I went by the tree would always smell strongly of eucalyptus, so I collected a few nuts and kept them with me in my travels, as potpourri almost.

Confidential

He gets me roses almost whenever he remembers when we're together. The pijama is really bad thing but let's put it that way.. it's full of his perfume put by him himself

Fantastic

I was leaving my country Egypt for a scholarship in the states and I felt the need to purchase some of the artifacts and little memorabilities to give out as presents for my future friends and colleagues... So I purchased some of the glass vases and cups and took them with me and a couple were too large and I ended up keeping them and I love them ... They are a peace of my culture and art and my pride to be an Egyptian where glass making was make into an amazing craft and we still hold many of its secrets and fine skills

I was getting married. I had an idea of how my ring I want it to look like. I saw the ring and chose it among other rings. I love it.

Every visit she always got us or gave us something. She forgo to get something and so she gave me and my brother 20 L.E note ... I never spent it because she passed away a month after

It's all about someone so special spares the time, money & effort to get something you really want

First personal souvenir from Venice

Words of God are priceless. They increase my faith and ease my heart.

Hope

I was leaving my friend after spending a long time together, not knowing if we would ever meet again

The different perfumes I used to wear remind me of that time

When we moved to this house

Paris Disney trip

The moment I was putting the key of my first abroad living experience.

Described above.

This was given to me as a birthday gift from a person I love very much. It was the only gift I've ever received that was not bought but rather held sentimental value

Family gatherings that feel safe fun happy

Happy and satisfied

It was an item I purchased and I fell in love with it when I saw it, it helped me heal and I was irritated when it disappeared but it is probably teaching me to drop attachments and not to depend on anything to give me security or anything like that.

It was on our first date

She was coming back from canada and it was a souvenir she got me from there, among other souvenirs i got from her on different occasions. But this one because it was useful i put it in my keychain and started using it

Smiles .. Kisses .. Fun

Before this item was given to me, I felt emotionally unstable as that moment I was in truly felt like I had failed, although this significant pin showed me that I had succeeded

My dad bought it for me when I was so little to even remember, I used to take it everywhere with me and still do.

My other half bought it for me before e even get the rings, I can go out without my ring but can't go out without this bangle at all.

Just a surprise gift

It's for my grandmother and she gave it to my mother and my mother gave it to me on my weddeing day

A birthday present

I have no memory of it.

I don't remember. I believe I was a baby. A friend of my dad's gave him to him as a gift when my sister was born and, somehow, he ended up with me.

As mentioned above...I was surprised, I felt gratitude and love, and I was in happy tears

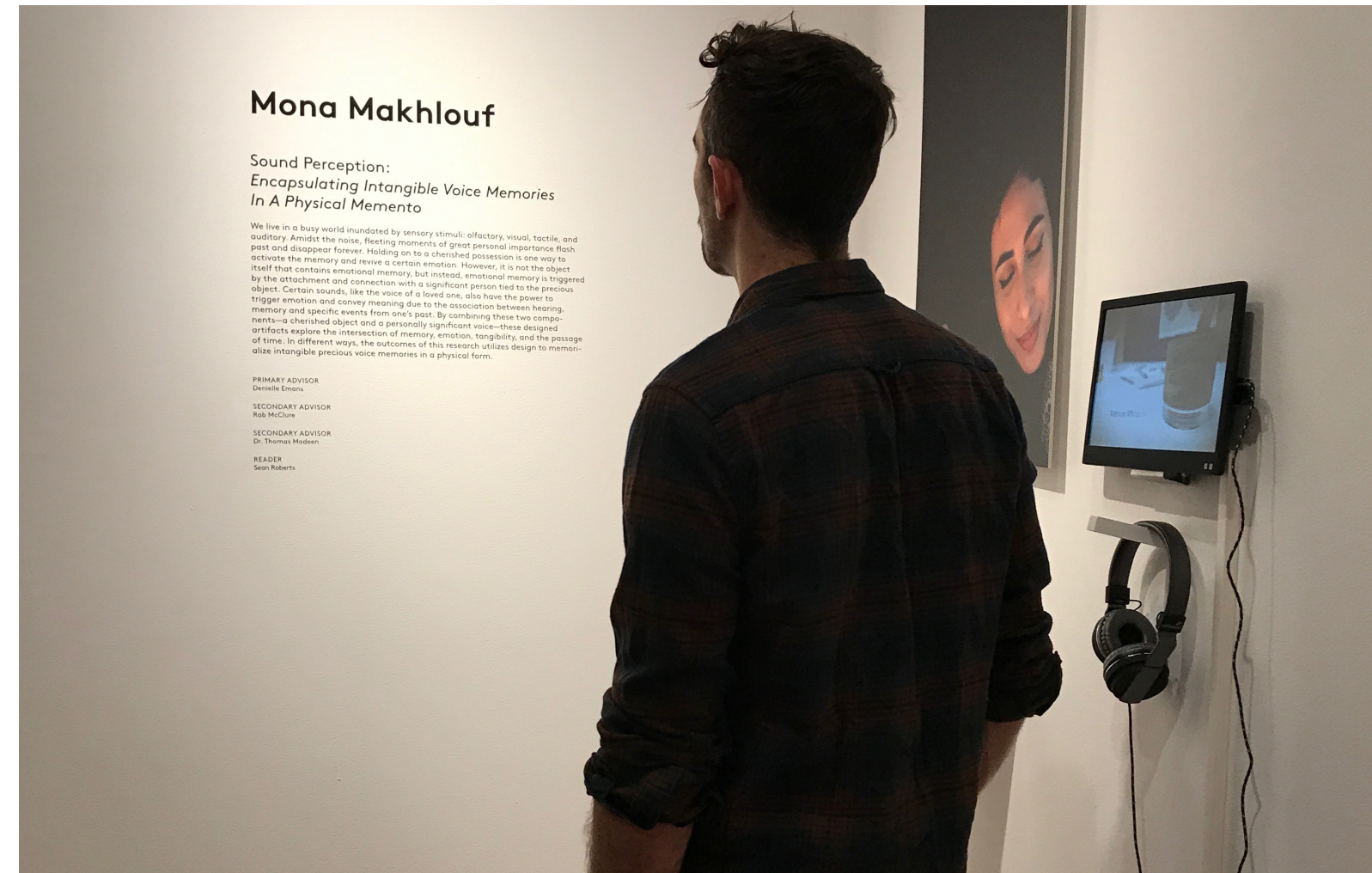
I don't remember the exact moment when I started to wear this ring. After my mom died, I particularly liked it, even if it is simple and not economically valuable, and I started to wear it. Now, I never remove it, unless I have to.

Some of them I got to have after my father and grandmother departed this world and one I got as a gift from the man I love.

A friend gave it to me while having a tour in Sayeda Zeinab Area

I bought this poster from the M.C Esher's exhibition .I didn't know that the exhibition was running and i was happy to find it running and to find a poster for my favorite Artwork .

Appendix 2



Mona Makhoul

Sound Perception: *Encapsulating Intangible Voice Memories In A Physical Memento*

We live in a busy world inundated by sensory stimuli: olfactory, visual, tactile, and auditory. Amidst the noise, fleeting moments of great personal importance flash activate the memory and revive a certain emotion. However, it is not the object by the attachment and connection with a significant person tied to the precious object. Certain sounds, like the voice of a loved one, also have the power to memory and specific events from one's past. By combining these two components—a cherished object and a personally significant voice—these designed artifacts explore the intersection of memory, emotion, tangibility, and the passage of time. In different ways, the outcomes of this research utilizes design to memorialize intangible precious voice memories in a physical form.

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