TouchME

Design for dementia: Role of Touch coupled with familiar soundscapes

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1 ABSTRACT

For those living with dementia, having constant reminders of familiar people, places, and things play a crucial role [34]. The representation of textures that insinuate familiar representations observed in everyday life by evoking memories and emotional responses. In addition to the tactile experience, researchers are investigating how soundscapes can reduce agitation and contribute to the well-being of people with dementia [22,28]. In this paper, I present the findings from scientific research case studies, qualitative observational studies, and documentary photography that explored the responses of participants at the KBO Kring Eindhoven (a care center, which organizes activities for people with early-onset dementia and their caregivers). Afterward, the compilation of these observations and scientific research helped produce a demonstrator of the final ideation which was then tested at the KBO following informal interviews with the participants. The findings reveal how familiarity feels comforting, encouraging reminiscence and selective observations. This attitude helped stimulate conversations, and connections between informal caregivers and people with early-onset dementia, emphasizing the implications of social cohesion which is important to them.

2 KEYWORDS

early onset dementia; observational studies; multi-sensory perceptions;

3 INTRODUCTION

As the global population is aging, the number of people living with dementia is increasing rapidly [31]. Unfortunately, there is little to no cure for dementia, and the possibility seems dim in the near future [9]. Cognitive impairment is of concern with progressing stages of dementia. With no available pharmacological needs to help to eradicate or diminish the symptoms, most families and caregivers look towards non-pharmacological behavioral interventions to enhance the individual's quality of life.

In particular, professionals and caregivers are looking for ways to reduce the drastic symptoms of BPSD [4]. BPSD, known as behavioral and psychological symptoms of dementia is the leading cause of assisted living which if left untreated leads to a reduction in quality of life [26]. BPSD includes emotional, perceptual, and behavioral disturbances. Hence, touching upon the emotional aspect which focuses on feelings such as euphoria, depression, apathy, anxiety, and irritability [7]. These emotional changes lead to changes in emotional and social behaviors, leading to differences in social and personal situations.

In addition, researchers in the field of HCI have been exploring the role of technology and design in adding value to the experiences of people with dementia and improving their

quality of life [22,28]. Withdrawal from social situations due to such drastic changes reduces the quality of life only fueling these emotional behaviors, hence, making them lose a sense of self and Independence. Therefore, using non-pharmacological means such as sensory and memory stimulation, however, can promote both physical and emotional comfort to people with dementia [4]. In particular, studies, have shown that tactile stimulation can increase feelings of trust and relaxation in people with dementia while giving caregivers and family a helpful direction to interact as well as a way for people with dementia to imply social cohesion. According to professionals, it is important to use familiar, nice-to-touch fabrics that work well, to name a few, are faux fur, corduroy, embroidered fabric, and felt.

As mentioned previously, the usage of soundscapes as a non-pharmacological method has been used in various forms of dementia care. From previous research, quoting an academic paper written in affiliation to TU/e, it has been duly noted that everyday sounds can offer cues for enjoyable social interactions between people with dementia and their (in)formal caregiver network [12]. Furthermore, research has also shown, sounds selected from everyday life and displayed to people with dementia can provide meaningful engagement by evoking memories and emotions which may link to previous experiences [13, 14].

There already has been existing research and interactive designs providing a multi-sensory experience and engagement for people with dementia. Indeed, the goal of this project was to investigate and research 1. Ways in which various modalities could be put into use to ease communication, 2. Types of scenarios this could play a role in, 3. Ways in which these evoke a feeling of being independent, and imply social authority, which in turn reduces apathy.

This paper presents the findings of field studies where various aspects were tested in an informal setting which will be explained elaborately further. The main focus was the people with dementia and facilitating a channel to communicate. Hence, the observational studies performed at the KBO were to co-create with the target group by focusing on their responses from a tactile experience to a multi-sensory experience. In addition, the relevance of these responses is an aid for authority and independence through communication and the ideal environment for use. Prior to the field studies, informal meetings with experts were conducted which will be briefly explained further, in order to gain expertise in the field of sensory utilization within dementia care.

The field studies were conducted in an informal setting with about 4 to 6 informal caregivers along with people with dementia. To gather data, the main researcher was present and conducted active and passive observations. A thematic analysis of the field notes revealed how inviting and utilizing multi-sensory experiences in dementia enhances the current emotional state and well-being.

4 RELATED WORK

4.1 Dementia and Design in HCI

View of meaning-making as contextualized, scholars in HCI have begun to attend to meaning-making by embracing the emotional, embodied, and cultural aspects of interaction with technology in everyday life [22]. The main goal is to provide methods of communication, in addition to verbal. Since the progression of dementia in many cases results in aphasia, leading to difficulties with speaking or verbally expressing themselves, in turn fueling symptoms of BPSD.

Due to this stigmatization, people with dementia are only identified by these symptoms [Behavioral and...]. Moreover, there is an ongoing protest to find a way to "reclaim and reframe" the concept of "self" in order to best position people with dementia [e.g., 19]. However, these practices haven't been continually adopted and are not in many of the settings people with dementia live in [5].

People with dementia are often excluded due to such stigmatization, demeaning them from social interactions and eventually being withdrawn. Hence, people with dementia need to be recognized for their different forms of communication and support their sense of belonging and social cohesion [22]. It is important to note that the "loss" of memory isn't a translation to the loss of their self-hood [Basting, 2003]. Researchers have begun to view

interactions in a more meaning-making, informative, and contextualized format through co-creation or ethnographic design work, placing people with dementia at the center [8,21),36]. In this paper, we build further on pre-existing work [e.g.,32,2] surrounding multi-sensory experiences within the context of HCI.

Such a form of HCI, re-centering the person with dementia, is known to design and work with experience. This puts us in a position to understand their lived and felt experiences, encouraging us to position the design as an empathetic response to this experience [28].

4.2 Physical and Embodied interactions

Works in HCI emphasize that bodily interaction and physical embodiment are vital for interaction [10, 16, 30]. In recent years, the embodiment has become a significant lens to explore knowledge and practice in social and health care, which holds implications for how we theorize and conceptualize conditions such as dementia [27].

Through attention to the embodiment, the body is considered to be a source of opportunity in relation to and between people with dementia [27]]. With such thinking, it allows us to look beyond the lacks and deficits, instead focusing on the probable ways they interact with emotional stimuli. Embodiment in dementia not only captures the social construction of surveillance, cultural priorities, and discursive conventions but as well as, the potentiality of creativity and self-expression digging deep into selfhood, sociability, and experience of dementia[20].

In his paper, Stephen Katz draws upon the "art of memory" or "ars memoria" that presents a worldview founded on the unity of body, mind, soul, and memory [18]. Hence, in a more embodied nature of the interaction, the discussion steers us toward an understanding of memory as acts of agency and imagination, at both individual and collective levels [27]. Hence, one can attend to the ways that people, even those with severe dementia, interact meaningfully through "the way the body moves and behaves". With such a notion, it shows that people along the spectrum of dementia continue to engage despite changes in cognition[22].

Researchers in HCI, have begun to look into interactions with physical objects to engage perspectives of participation for people with dementia [22]. In the paper, "Making as Expression: Informing Design with People with Complex Communication Needs through Art Therapy" [23], the main conclusions surrounded how people with dementia used materials to understand meaning-making and the language of materials. This process gave the spotlight to the unfolding process through their individual "functions and uses". The process of creating through the individual's process strokes a sense of their self-hood. Creating the modality as well as the modality itself says "what's important to the person and what the main point of connection is". Hence, such a type of interaction fulfills a connection in regard to sociability.

4.3 Multi-sensory Perceptions

To this end, researchers have encouraged sensorimotor engagement by recommending activities leading to repetitive and rhythmic experiences [25]. Dementia is characterized by the presence of cognitive decline, which leads to sensory-perceptual alterations, often making them withdraw from activities of daily living. The objective is to review the effectiveness and characteristics of sensory stimulation by including people with dementia in the design process [33].

Participatory Design fosters close contact between designers and people with dementia, hence, introducing empathy into the design. The characteristics of experience centered-design advance a humanistic approach by understanding the relationship between people and technology [37,28]. Hence, with this, the advantage of ways in which people with dementia experience, sense, and express themselves is taken into consideration [24]. Providing a channel to express themselves, implicates a sense of self-authority within the social scenario inviting them into conversations. With such participation, emotional understanding takes the foreground and highlights the strengths of people with dementia.

4.4 Existing Solutions

Multi-sensory interactions stemming from embodied and physical technology are in existence within dementia care. Nit-picking these stimuli allow people to feel emotionally connected to their own space, this is prevailing in environmental design for dementia care. Preliminary evaluations contribute to the well-being of people with dementia. This approach not only optimizes existing environments but provides novel solutions to the problems people with dementia face on a daily basis, improving their quality of life [Multi-Sensory Environments in Dementia Care, 2018]. Furthermore, there have been solutions surrounding digital media making it the main artifact for reminiscence therapy. Media are a means of giving people with dementia ownership of conversations and helping them reminisce [15,1,5]. A topic that is being widely explored in HCI. A known example would be a scrapbook that contributes to the meaning-making process for people with dementia. To add, there are various ways interaction is established by using demonstrators emulating familiar sounds, videos, and/or photos.

Apart from this, textiles have been a topic of discussion for facilitating sensory-enriched environments and meaningful occupations for people living with dementia [17]. Sensory textiles with embedded technology provide stimulation and distraction, providing space for personalization [36]. One such example is the Dementia apron, which is over-garments, containing stimulating surfaces to grab, touch, and fiddle with including buttons, beads, and zippers in assorted colors and patterns [36]. The experience is further enhanced by adding audio stimulants such as various sounds and vibrations.

5 METHOD

This report encompasses the ideation and iteration process taken, making the necessary design choices that led to TouchME. The main goal was to gain the perspective of people with dementia, in order to design with more empathy and keep the target in the center. Hence, a series of observational studies were performed in order to gain a deeper insight into touch, movement, sound, and compilation of touch and sound to provide an experience. Furthermore, informal meetings were conducted with experts in order to produce a clearer definition of my main research goal as well as the various aspects to achieve it. Moreover, to briefly understand how technology could be integrated into dementia care and in ways, they could foster connections. However, the experts were not considered spokespersons or proxies for people with dementia. Even if, the information gained was minimal, it was predominantly interesting to gain insight from people working closely with people with dementia.

5.1 Subjective Goals and Focus Directions

The focus is set on early-onset dementia to understand the needs or wants of such early progress. People with early-onset dementia go through changes in behaviors regression into emotional disturbances, Often repetition of actions and questions unable to consider the consequences of the actions, a few suffer from sensory perceptions, furthermore, also a slow loss in memory encircling remembering names, and tasks, and/or misplacing objects. As the stages progress, their body becomes more vulnerable unable to protect themselves from various aggravating diseases. My main focus was coveted on characteristics more present rather than lost, hence, shifting to activities that would help jog their memory providing reminiscence. With such a quality, it was feasible to indulge in experience-centered design to dive into the world of dementia and its care. The common most characteristics that people with dementia search for are, social connectedness, independence, and active participation, hence, being able to express and converse with themselves.

I, as a designer, wanted to bring this goal to its fruition by taking a participatory design approach in creating something physical that would speculate and bring out their experience in the rawest form. The usage of hands for touch is known to be helpful to manage and reduce behaviors associated with dementia such as anxiety, agitated behavior, and depression. Building on existing research, to aim for independence while decreasing apathy,

which leads to improved social relations through sensory perceptions. With this, the idea is to produce memories in the present while reminiscing memories of their past which has an effect on their near future.

5.2 Iterations

At the beginning of the project, the focus was to be able to create an expression of art through which their experience and expression could be communicated. This was to provide them a platform to express themselves how they pleased. Hence, there was a variety of scientific research being researched surrounding art in dementia care and its benefits. Taking inspiration from this, there was a need to create a sub-challenge to create an environment to reduce apathy. The goal was to integrate movement and spontaneity into their daily activities, hence, it was viable to provide space for expression, in the following ways:

1. Decorative House: By creating a decorative piece for in and around their personal space, which can be done through malleable materials. This can be created by a loved one or together with a person with dementia. The idea of the decorative piece is to store valuable reminiscing information related to their loved one, such as a memorable audio experience, made more experiential by providing a visual perception through NFC chips providing more cues for people with dementia(see Figure 1). This was more of a hypothetical formulation of a solution accustomed to the physicality of technology which could be revisited in the future to help reminiscence. It was inspired by LivingMoments [Thoolen et al., 2022].

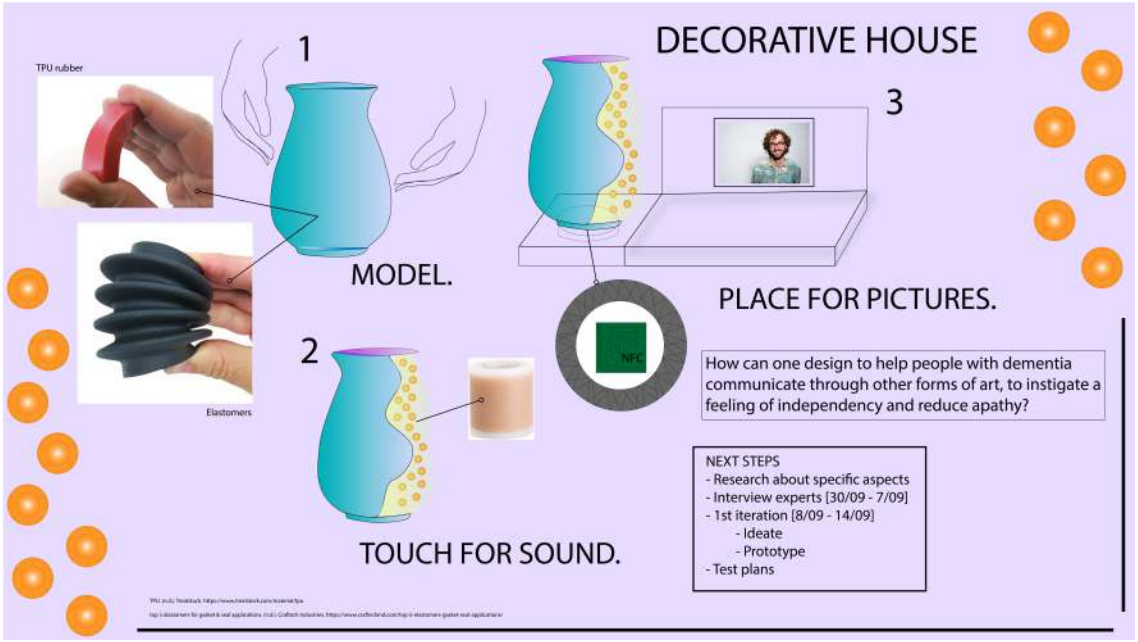

Figure 1: Poster explaining Decorative House

2. Another solution was to experiment with music providing space for people with dementia to create amongst themselves or with their loved ones. However, the idea was to keep tactile expression as the baseline through which music is expressed. With the movement of their fingers and touch, activities such as knitting, stitching, clay modeling, etc. trigger playful audios.

The next steps were to focus on the quality of life, as well as the problem behaviors with the target group being people with early-onset dementia. While researching to choose a direction to focus on, vast scientific research was done on art such as drawing and painting was studied, and ways it improves their quality of life. It was interesting to note, according to a specific study [ ], that appreciative and active responsiveness and interaction with others depend on the severity of dementia, as well as the type of artwork presented. Moreover, in a paper that worked towards the development of technology for art therapy and dementia

[], most users preferred to be able to self-advocate without being advised immensely. These studies also used facial expressions to calculate the user's engagement and were usually engaged with visual, verbal, and gestural techniques.

After this, the design challenge was redefined to "How can one design to reduce apathy by instigating interactions through other modalities other than verbal communication". I decided to jot down aspects I wanted to focus on, such as the physicality of technology, meaning-making, technology facilitating a persistent emotional connection, and multi-sensory experience. Hence, further ideation focused on trying to provide different options for people with dementia to choose from to make it more personalized and allow for meaning-making and emotional connections. Even though it followed the same direction as the first ideation, this was grounded in further scientific research which defined the design challenge more clearly.

5.2.1 Midterm Iterations

To ideate along the lines mentioned above, a compilation of music and art induced in an idea was chosen. This will be explained further below: It was divided into 3 parts. The look and feel are similar to an old-fashioned radio, to connect better with the target group and make it more familiar for them.

1. Incentive: A visual of a cherished object is sent to the digital screen of the old-fashioned radio, placed in the space of the person with dementia.

2. Old-fashioned radio: Looking at this incentive, the person with dementia has the opportunity to create music, to express themselves. The idea here is to use buttons where each has the functionality of bass, drums, and acoustic guitar, also known as a simplified DJ set. There would be a set number of buttons for each of these three areas. The buttons were taken inspiration by a communicative device used for animals (see Figure 1).

3. Reward: The DJ set is connected to the radio, and the music gets recorded in real-time. After which, the recorded music can be sent back to the loved one. Furthermore, the idea is that the recorded music, which is processed as sound waves, can be printed out. This section is physically interactive, due to which, the music can be played back when touched throughout the areas of the printed sound wave.

Taking into consideration the above ideation, I aimed to touch upon; Physicality of technology, Offering different options, Meaning-making, and Multi-sensory. Each of these supports an emotional connection and expression. However, after feedback from the coach, it needed to re-evaluate. Accordingly, presenting a set of buttons does not comply with artistic expression since it is construed. Hence, it was further ideated to provide an interface that could be manipulated, played with, and through touch to express themselves. This was followed through and presented on the Midterm Demo Day (see Figure 2).

Figure 2: Using the old-fashioned radio

5.3 Midterm

During the Midterm presentation, there was quite some feedback surrounding the over-complications of the demonstrator. People with dementia having such a progressive state, lose their cognitive abilities with time. Hence, it is important to create an atmosphere of

simplicity and playfulness to be in touch with themselves and the people around them. Moreover, it was important to shift the focus to ways to use the artistic abilities of people with dementia to their advantage giving a clear overview of the actual functionality of the demonstrator. Hence, it was necessary to focus on the tactile expression using various textures which solely invite them to touch to be enhanced with an audio experience.

Figure 3: Posters for Midterm Demo Day

5.4 TouchME: An Interactive Cloth

TouchME (see Figure 4) is an interactive cloth that offers a flexible, tangible interface for a multi-sensory experience for people with dementia to provide them with n array of textures to fidget, touch, squeeze and move around through. TouchME provides scenery of naturesque, rustic aspects found outside and that we come across on a daily basis. Each aspect, one such example: as the trees, was translated into a texture that resembled the touch and feel when running your fingers through the leaves of a tree. The cloth is divided into 4 modules (see Figure 5), where each area encompasses a particular array of the scenery of textures. Each of these modules is connected to a sound if the person with dementia was present in such an environment. As of now, the sounds are connected through a processing sketch which is played through the PC, however, added within my future steps it would be eventually connected to an android system app UI compatible with the processing sketch to allow the (in)formal caregivers, family to be able to add sounds, make personalized playlists, giving them space to control the volume levels as well. By doing so, it would be much easier to communicate the sounds through a separate speaker (see Figure).

The cloth is placed on an elevated platform which acts as a sound touchpad, hence, this is ideal to be placed in a familiar and safe space that the person with dementia recognizes. Yet, the wood-like finish of the platform with pastel-like colors of the cloth makes it blend in a home setting, while the various 3-D textures provide an inviting outlook for visitors and

Figure 4: Speaker placed within or outside the platform

people with dementia. The choice for the cloth is to give it a flexible feel and look, where, the user could grab onto the soft underlying texture. With further altercations, the touchpad along with the speakers would be integrated into the cloth allowing it to be placed close to their body, making it personal.

Figure 5: TouchME

5.4.1 Design Choices

Following the decision to create an interactive cloth, the next step was to make a few design choices to implicate a tool that is inviting. Firstly, I had no experience of using a sewing machine, henceforth, I encouraged myself to get accustomed to the reigns of using a sewing machine. Secondly, I decided to create a prototype of various textural designs for a leaf. One has layers when stitched horizontally, and another has layers, created when the needle is continuously moved in circular motions producing a bulk of rough layered textures. Furthermore, I started to experiment with ways in which I could recreate the feeling of moss, by which I had experimented at the KBO during my third observational session. The idea was to create an array of the pointed yet thin layered palette.
Hence, following this as well as gaining feedback from the coach, the next step was to follow through by thinking about what needed to be included in the cloth, the color palette of each aspect to create the scenery, and the different materials to create each aspect. Hence, a color palette of pastel colors was chosen to provide a soft look to the eye, yet not intrude on their space. The colors chosen for each aspect, such as the trees, bushes, clouds, leaves,

the lake, and so on were constituting a palette similar to the state it is found in nature. With the cloth base chosen as a light turquoise color, the other colors were complimentary to the turquoise, as visible in the Figure below.
A large part of the textures was surrounding felt, faux fur, and embroidered fabric to communicate every section as similar to its natural state. Hence, the autumn leaves depicted were considered to be a rough hardened texture, with a few protrusions in the texture, over which a felt pipe was stitched to imitate the touch of stems and branches. Furthermore, the leaves of the trees were represented by felt in different forms, which are hollow sponge-like balls made of felt as well as felt curled up with protrusions of various layers. The lake is represented with embroidered fabric stitched upon a shoe pad, to depict the flexible wave-like feel and look as well as the felt material to show the stinging rough feeling once the wave crashes into a solid object or onto the shore. This is a play on the look and feel of the waves. Apart from this, the rain clouds are depicted in a grayish color with the use of faux fur material to depict the light and clustered erratic representation of the clouds, with the rain depicted by placing marbles in a stitched bag, which is attached to the cotton cloth with a Velcro. The wet mud is also shown, with the help of a sponge

5.4.2 Array of textures: Create a Scenery

To study the role of textures amongst people with dementia, and in the care system. Different designs with different textures were thought of in order to experiment with the type of interface needed to be presented to the users. After the observational studies (further explained under the study set-up), it was necessary to zoom out to focus on more familiar and generalized settings to address the main research goal. Further, various aspects of the cloth will be explained with reference to 4 modules. It was more apt to create a scenery with a clear and complete picture instead of a randomized array.

Hence, we begin with the feeling of a rough yet playful texture of felt for the trees (on the top right). The trees surrounded by bushes and mountains are named Module 1 which are marked as 1, 5, and 8 respectively (see Figure 5).

As we move to the left of this module (on the top left), we come across clouds with a faux fur texture to depict the soft airy feel and look. The material used for the clouds is dark-grayish in color, to paint rainy clouds. Taking this into consideration, there is an impression of rain falling from above. This is shown through a stitched bag having illustrations of raindrops, which are filled with marbles. This is done so in order to express the compilation of droplets that you can play in. This is named Module 2 which is marked as 2 and 3 depicting the clouds and raindrops respectively(see Figure 5)

Further down below, pieces of cloth shaped like leaves are stitched on to depict autumn leaves. This is named Module 3, which is marked 4 (see Figure 5) having a raggedy texture with rough edges compiled with hard felt-like stems. This is to give the user a feeling similar to walking on dry autumn leaves providing audio as well as a tactile experience.

Furthermore, this experience is more enhanced with a furnished look of a lake, along which, is an arrangement of bushes popping out of the cloth. These bushes are either pointy or patches lined alongside each other, inviting the user to move their hands in one long filed movement, this is marked as 5. The waves are showcased by adding a spongy texture underneath, to translate the soft flaccid feel of the waves with felt texture stitched upon to depict the feeling of waves when it crashes into an object, which is marked as 6-7 (see Figure 5).

Amongst the bushes, there are fragments of acrylic stones to depict the feel of grabbing and/or touching stones, named Module 4, marked as 8 (see Figure 5). This is also visible filling up the outline of the mountains, also marked as 8. All this is brought together as walking through various environments is provided with a tactile experience.

5.4.3 General Sets of Nature Sounds

The tactile experience is enhanced by adding an audio experience providing a multi-sensory perception. Here below, the sound connecting each module will be explained. Modules encompassing which of the respective areas have been explained in section 6.3.1. To further

understand which sound is connected to which module, please refer to Figure 5.
Module 1: Connected to a sound similar to experiencing a walk-through of a forest environment. To briefly explain, trees blowing in the wind, and different types of birds chirping in the background.
Module 2: To communicate the look and feel of rain clouds, it is connected to a compilation of sounds containing thunderstorms, rainfall, and rough winds.
Module 3: Here contains an array of leaves to be similar to autumn leaves. The sound is connected to provide an experience as though the user is walking on dry rough leaves, which can also be picked up.
Module 4: Sounds here provide an experience of being at sea, such as the crashing of mountain river waves, the rustling of bushes alongside as well as the sounds of pebbles being thrown into the sea.
These sounds are only activated when touched in an area overlying the touchpad on which the cloth is placed. The sounds are played for a short period, triggering playful responses. For each of the modules, four high-quality sounds were selected from an open source [11]

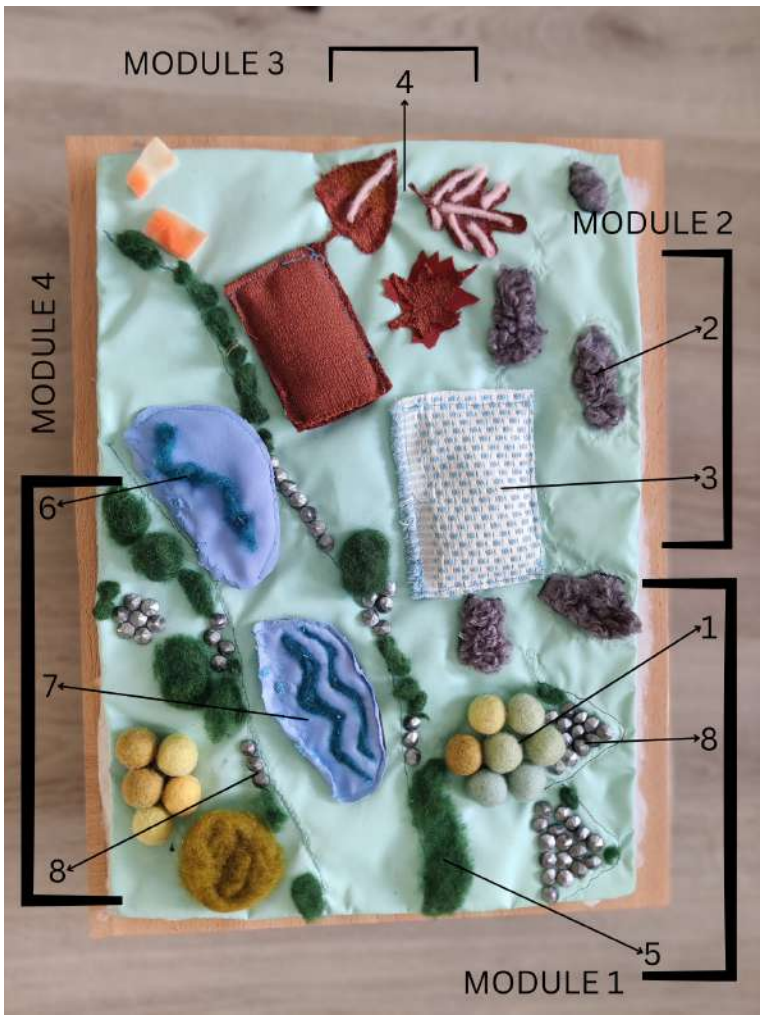

Figure 6: Division of Modules

5.5 Electronics

Here, I will explain the electronics that have been integrated to make the cloth interactive. The platform that the cloth is placed on acts as a touchpad. Underneath taped are aluminum pieces to which various wires connect to a touch sensor. Each touchpad recognizes the touch

of the user in that particular area, when the Arduino registers which pad is touched, this information is sent to the processing sketch where each pad is stored to a particular sound as mentioned above. To have an acute visualization of the electronics. The first figure shows the simple touchpad on which the cloth would be placed (see Figure). The next figure shows the wires being connected to the Arduino (see Figure 6). To be able to see the code, check the Appendix.

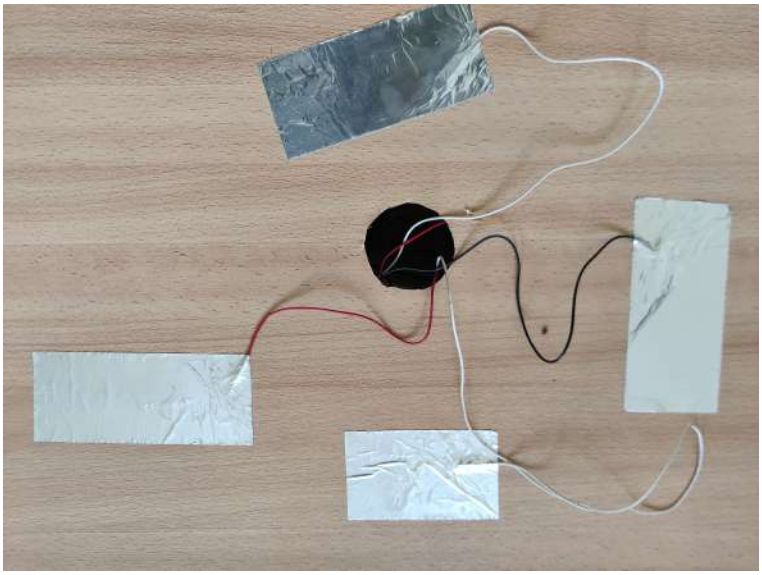

Figure 7: 4 touchpads divided into 4 Modules

5.6 Settings and Participants

The field study took place at KBO Kring, located in Eindhoven, in a very informal setting. Every Wednesday, various activities would be planned for the participants which lasted for about 2 to 3 hours. Due to the tight scheduling and the informal environment, user tests needed to fit in within this time period. Since it was an uncontrolled environment, various distractions came into play, which was difficult to maintain attention with a vulnerable target group. There were a set of three observational studies done, in which varying sets of participants participated. A maximum of 10 participants were jotted down according to the Ethical review board form. At the KBO, There were 2 females and 2 males with early-onset dementia [PWD1 - 4], which, constituted 3 to 4 informal caregivers of said people with early-onset dementia. The KBO is known to conduct activities for people with early-onset dementia. The target group ranged from the ages of 65 and 80. Before each observation was conducted, a brief explanation was provided for the participants to understand the criteria, research, and goal. The studies that were performed revolved around observational aspects, with questions asked during the test to help divert and focus their attention on the test being performed. Consent was asked beforehand to be able to document their feedback as well as digital documentation. However, due to ethical reasons, any recognizable features needed to be blurred or covered up.

5.7 Ethics

This research needed approval only from the squad since the target group involved was not extremely vulnerable. A brief verbal consensual consensus was given after the introduction of each user study. The observational studies were conducted in a very informal manner, with various interactions happening between each and every participant and the caregivers followed by discussions about previous anecdotes and reminders. I, the main researcher,

focused on behavioral language, body language, and speech, as well as, several informal non-leading questions were asked forthwith to gain further understanding.

5.8 Preparation for User Study

After the feedback received on the Midterm Demo Day, it was necessary to re-think and re-evaluate the design choices, in order to create a more feasible design. As mentioned above in section 5.3 Midterm, iterations were purely done based on scientific research, hence not taking into consideration the person with dementia. Therefore, it was vital to follow through with the participatory design process which has been mentioned earlier.

It was important to shift focus on one particular aspect from the Midterm prototype. According to the feedback received from the coaches and peers, there was a question about ways textures can be manipulated to provide a clear story for the person with dementia that they are able to express clearly.

Hence, the next step was to make the usage process as easy as possible keeping in mind the target group. By cutting down the extra actions and multiple demonstrators, for example with the Midterm demonstrator, it was advised to only focus on the action which actually helps create the music and propose to remove the old-fashioned radio with its digital screen since it did not play a vital role, making it more confusing for the people with dementia. Furthermore, to help with the musical aspect in order to help ideate further, I attended a music workshop conducted by the artistic director and his fellow music therapist of Embrace Nederland who works with people with dementia.

5.8.1 Music Workshop

The Workshop was held in Tilburg and was conducted in Dutch yet was very interesting to be a part of. Most of the workshop was surrounded using objects lying around as well as our own bodies as an instrument to express ourselves. There were notes about how enunciating verbal speech in different tones can affect body language and expression. Furthermore, exercises are based on awareness of music and/or sounds, especially in their immediate surroundings. Ways in which this could be recognized, picked apart, and used for one's advantage. Discussions about the therapeutic use of music and developing one's creativity and musical taste. By making music themselves, they develop close contact with people with dementia. This was interesting to see, regardless of having a musical background, listening to and creating music together creates an opportunity to communicate in a non-linguistic way with people with dementia. Even though, the main aspect of my project was not to create music together but be a by-product through tactile expression. Attending this workshop helped me understand the large array of ways music is used as a connective tool. Talking to the experts, made me understand the center of any tool is the people with dementia, creating an easy form of communication involving their body, formulating scenarios in which such a tool could be used, as well as, reasons to make use of such a tool.

5.9 User Study and Procedure

In order to gain more insight, I wanted to test out two different aspects separately and understand their reactions clearly. Hence, the sessions were divided into three 1. Observational session on randomized textures 2. Observational session on familiar music, as well as, familiar sounds heard in open and closed public spaces 3. Observational session on the coupling of natural elemental textures and familiar nature sounds. Before each session, an introduction was given about the following session to prepare them. Participants who are the caregivers are referred to as C1 and so on, whereas, Participants who are people with dementia are referred to as PWD1 and so on.

5.9.1 Observational session: Randomized textures

The goal of this session was to observe ways in which they understand a set of randomized textures, also paying close attention to their movements while interacting. A set of 6 play-

things were passed around in the room. The tool as well as the reactions will be further explained below.

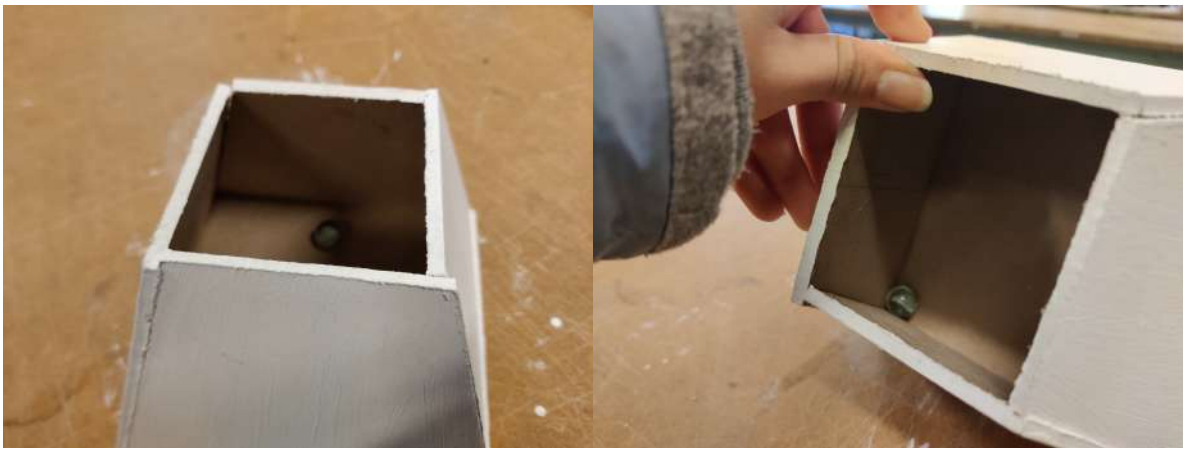

Figure 8: Movement

1. The first plaything that was passed around was a trapezium-shaped object, in which a marble was placed (see Figure). Most verbal interactions were performed in Dutch, however, with the help of other students around, it became easier to understand while thinking out loud as well as simultaneously observing their body language. However, due to the informal group setting consisting of informal caregivers and people with dementia, the reactions and responses were noted in an erratic and randomized order.
C1 expressed this object is similar to "Lamp Kampia" (see Figure 7). It was interesting to notice, even though there was only one marble present, the participants were intrigued and continued to rotate their wrists while holding it to set the marble in motion. One of the participants connected this demonstrator to a play-thing which is a maze with a ball in it, where the user must navigate the ball through the maze.
2. The next object was a surface-changing object (see Figure 8). This was included to ob-

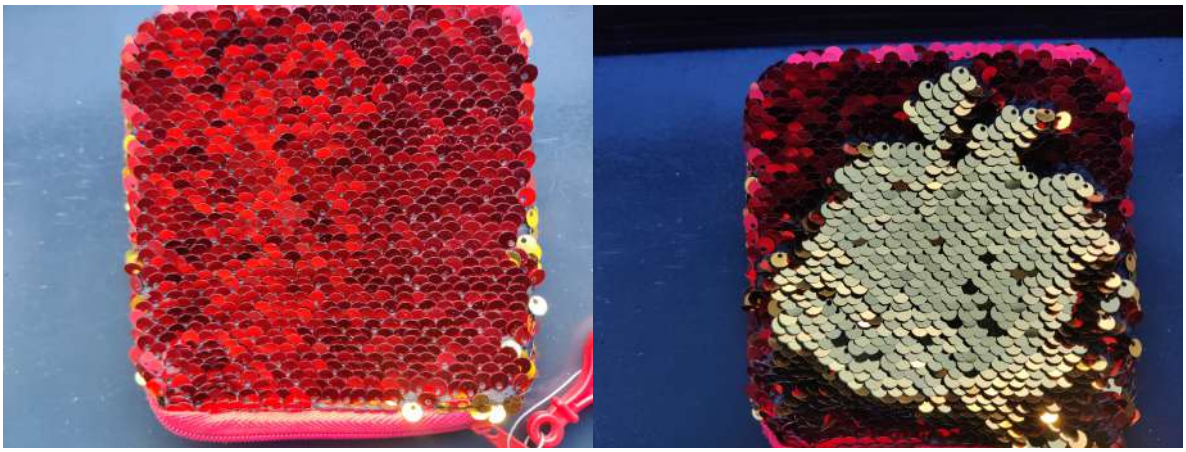

Figure 9: Surface changed with hand movement

serve their movement while moving through the surface, as well as, their tactile expression. C2 thought out loud that while moving their fingers through it, and described movement across one direction as being obstructive while moving the opposite direction is smooth. PWD1 did not want to interact with it even after being nudged by her partner C1, after which she expressed clear negation stating that she did not like the texture of it. However, even though, some people had some negative opinions of said texture yet they continued to interact with it. Furthermore, they similarized it to the scales of a fish.

3. The next object was a hairbrush (see Figure 9). The side with the bristles stuck out to the participants and invited them to touch it, expressing a resemblance to the body of a hedgehog. The rubber bristles, with pointy ends, invited them to continue interacting with it.

Figure 10: Interacting with the bristles

4. The next object was a box-shaped filled with thermocol balls (see Figure 10). The box was made out of an inundated surface, making the balls roll into these sections. However, most of the participants were unable to express their emotions and did not experience much. PWD 2 expressed disbelief and that the balls were sticking to her hands which wasn't amusing. C3 expressed that while moving the balls around, it sounded like mice were walking around, which was a funny anecdote.

Figure 11: Touch and movement with thermocol

5. The next object was clay. C4 expressed that this was very vital for anger management while sculpting the clay. C4 was trying to create a shape of a box and was very concentrated

while doing so (see Figure 11).

Figure 12: Touch with malleable texture

It was interesting to observe how the participants connected these objects with different textures to familiar objects that they have come across. Most objects were connected to natural elements that were present in nature. However, this was to get a feel about what texture felt more comfortable to ideate on as well as in what ways would the participants interacted with textures.

5.9.2 Observational session: Familiar music and sounds

The goal of this session was to observe ways in which people with dementia would react to music while paying attention to their body language. During activities, there is usually some music that plays in the background, which ranges from the early 60s consisting of English and Dutch pop, jazz, and rock songs. This was helpful since it established a social connection offering the researcher insight into their lives with tacit and implicit forms of expression. During the session, I decided to take field notes, these field notes were then expanded into field texts explaining the emotional aspects while experiencing the activity. This session was divided into two areas, 1. Familiar music and 2. Familiar sounds

1. Familiar music: During the first song "Non, Je ne regrette rien", PWD1 started to move her body while singing the lyrics. She wasn't aware of knowing the lyrics whilst she sang. She mentioned that her mother used to play this song when she cooked.
There was an accumulation of participants moving their bodies to the music and singing along, whereas some just sat there enjoying the environment created. On that day, all the participants were sitting around the table, enjoying some cookies and drinks and having conversations amongst themselves. PWD3 expressed that the music did not really affect him in any way, however, was aware and liked that it played in the background. Few of the participants were tapping their fingers to the beat, this was nice to see the ways in which they joined in with the song without singing. PWD2 expressed appreciation verbally that songs from his days were being played, whilst he smiled and listened with eagerness.

2. Familiar, natural soundscapes: These sounds were played in random order when they were engaged in conversation amongst themselves. First, the chirping of birds was played, and due to the lesser number of participants, this grabbed their attention instantly. C4 instantly got reminded of a painting he had painted of 2 birds, of which he showed a picture to the others present in the room. It was interesting to note how this started a conversation. In addition, the sounds of church bells with a rustle of wind were played next. Hearing this,

Figure 13: Palette of dry autumn leaves

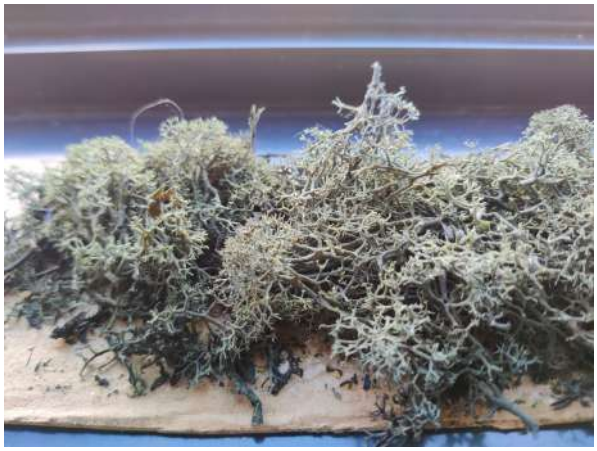

Figure 14: Palette of moss

C2 got reminded of a convocation he lead at the St. Catherine church last year. He proceeded to show a YouTube clip of this event and everyone watched in awe and was impressed. This again started a dialogue, change in body language, exchange of compliments, and intriguing behaviors.

5.9.3 Observational sessions: Touch coupled with audio

After the previous session at the KBO, it became more obvious that people were more reactive to sounds persistent in nature rather than sounds that they would come across at every other moment of their day, for example, sounds heard in a bustling restaurant, familiar sounds while cooking, sounds heard during busy working hours and so on. Taking into consideration this reaction, along with feedback given during the first session, a clear conclusion was drawn that participants were able to connect every texture to an anecdote that was more familiar and known to everyone in the room. Moreover, after testing the sounds, it was clear they paid more attention to clearly defined sounds, such as the chirping of the birds, the rustling of trees, and waves crashing against each other. Since this was more tangible to grasp, they were attracted to it.
Hence, the goal of this session was to observe when they are able to enjoy touch and sound in relation to the touch to enhance their experience. Therefore, palettes of elements in relation to nature were made, such as a palette of dry autumn leaves and branches, and a palette of moss (see Figures 12 and 13).

When the palette was presented to them, this did not necessarily invite them to touch it, considering it was bland and plain to sight. Moreover, when asked to touch, they did so with undeterred facial and body expressions. They weren't aware of the underlying goal. Following the next actions, this was made more experiential by adding a sound while they touch the surface. For example, while touching through the palette of dry leaves, the sound of someone walking through a path filled with dry leaves gives out a crunchy sound. Listening to audio when it is being touched simultaneously, intrigued them and changed their facial expression, inviting them to keep touching it further. Whilst being familiarized, their body also began to relax finding comfort in the actions.

C2 was more intrigued about the things placed on the table. Immediately started guessing and touching things, especially when she came across, clay wrapped in cloth. She

proceeded to guess it and was surprised to find out it was clay. Following this, she proceeded to talk about it and in an excited tone inform her partner about it (i.e., PWD2). C2 also compared the dry leaves to the touch and feel of chips, making her burst into laughter. Furthermore, PWD1 was distracted from the surrounding noises when asked to touch. However, when a sound played whilst she touched it, she responded by saying "Hello" with an expression of shock. Moreover, PWD2 started picking apart the sounds while touching the palette made from moss. He noticed the sounds of birds chirping in the background and began to imitate it with the hands shadowing the beak of a bird. A replica of a cutting board along with a knife, which when moved in a cutting motion was accompanied by a cutting sound that PWD2 related to a woodpecker's sound (see Figure 14).

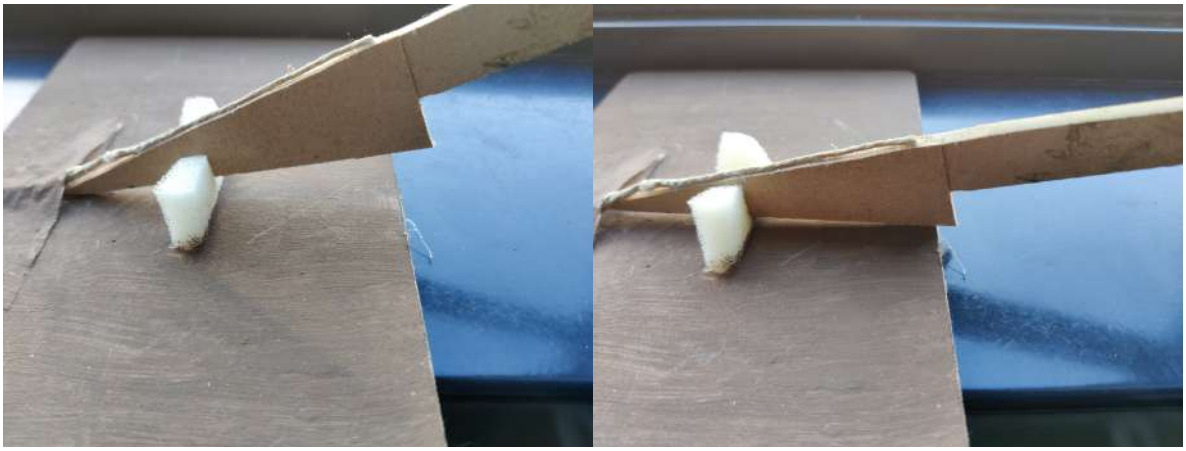

Figure 15: Movement coupled with sounds

During this test his face lit up with a smile, he felt more welcomed and was more curious. He proceeded to even compliment this feeling by saying "nice" in English, given that PWD2 had problems with speech and usually communicated with nods and/or in Dutch.

5.9.4 Design Choices

Taking, the previously described 3 sessions, into consideration, certain design choices had to be made. In the first session, a set of randomized movements and textures were presented. This was to form a conclusion about the ways participants would interact with such varying forms, ways in which touch could help to express themselves, create a space to talk about experiences, and start a dialogue with others in the room. This was also to understand, what textures involved more reactions and dialogue.

With the next session, there have been multiple studies done on the effects music has in dementia care. Even though, recognition surrounding familiar sounds is minimal being more prominent with personalized soundscapes. Studies surrounding familiar soundscapes such as nature soundscapes have proven to improve quality of life, which is mentioned in section 4 under Related Work. Hence, I wanted to test out some familiar sounds, and ways in which they would react, to be able to know what type of tactile expression to create forthwith. Since, they felt more intrigued with soundscapes with familiar and clearly defined noises, encouraged further design choices where a more structured and general form of textile expression was chosen. I decided to focus on replicating textures of natural elements found in nature, by creating a similar visualization, hence, making it familiar, inviting, and recognizable.

Hence, as mentioned in section 4, under Related Work, people with dementia were more receptive to certain kinds of materials and felt the experience to be more enhanced with other sensory perceptions such as when sounds were combined with the tactile expression. This improved their quality of life while altering and/or improving their behaviors for their own ease.

This choice was further supported and made conclusive in the third observation session. Hence, an executive choice was made to create a scenery using different textures, visuals, and sounds on a cloth since it would easily allow the user to be able to grab, touch, fiddle, and so on. However, to integrate working electronics, there needed to be made some changes to make it as technical yet feasible as possible. This will be further explained in the section under Future Works.

5.10 Final User Study

The final User Study was conducted after the final Demo Day with the integrated electronics to receive the complete multi-sensory experience. Creating a rapport with people with dementia suffering from a few cognitive disabilities by connecting with each other using this common tool.

6 RESULTS

In this section, I discuss an analysis of the field notes taken in the Final User Study.

6.1 Cueing Meaningful Conversations

Figure 16: C2 (on the right of the image) is guessing whilst nudging her partner PWD2 to touch it as well

Most participants were able to recognize the various sounds and were encouraged to start conversations. As mentioned above, connections were often made to experiences they had previously come across in their lives. The participant-observer created a personal dynamic and blend in within the care center, building trust with the participants and familiarizing myself. Touch itself acted as an instigator of conversations which is contradictory to the previous observation session conducted at the KBO. The test was first conducted without audio being plugged in, hence, When invited to touch the cloth C2 browsed through the cloth trying to feel and guess every section stitched upon the cloth. Whereas, PWD2, who has speech problems accustomed himself to the cloth using intense concentration. C2 took over the conversation by guessing what each texture reminded her, such as, the feeling of felt texture reminded her of fillings within pillows while saying it to her partner. PWD2 continued to move his fingers throughout, agreeing with his partner. When the audio was played, both PWD2's and C2's curious expressions changed into astonished expressions.

PWD3 expressed concern about it would be very hurtful to walk on the acrylic stones depicting stones and pebbles, which makes him point to the texture of clouds and says "Walk here instead!". It was interesting to see, how PWD3 had a lot of things to say, such as complimenting it continuously with compliments "mooi" "leuk". He felt through the cloth for about 15 minutes expressing curiosity, astonishment, and satisfaction. Furthermore, he advised me to be careful of the acrylic stones since they might fall off, and expressed thoughts about felt texture as well saying "this washes off really well".

Figure 17: C2 (on the right of the image) looks over for confirmation after she has guessed whilst her partner PWD2 continues to explore

6.2 Non-verbal Expression

Even though these expressions were quite subtle, it was interesting to observe their intrigued body language while not completely grasping everything but continuing to move their fingers through it. Furthermore, PWD2 contributed to the conversation with nods and listening to his partner explain what each texture reminds her of. Moreover, PWD2 bowed his head close to the risen platform on which the cloth was placed to discover where exactly the sound was playing from, as he continued to move his fingers through it. They continued to press, grab, and point at the cloth.
PWD3 listened in on the conversation with concentration, also reciprocating this while we spoke to him. He expressed positive reactions and affirmation with nods and slow blinks.

6.2.1 Connecting through Sounds

The experience was enhanced with the addition of sound with touch as described in the previous sections. When the sound of walking on dry leaves was activated with touch, PWD2 AND C2 simultaneously said "Oh that sounds like walking on a lot of leaves!" in an exclamatory tone, was interesting to know the unison and connection formed. When PWD2 heard the sound of waves crashing activated with touch, he smiled lighting his face up, while continuing to move his fingers through the indentations of the embroidered fabric depicting water. Upon hearing the sound, PWD2 exclaimed "Water" and everyone sitting around him agreed with satisfaction. Reacting to the sounds was a form of communication between the person with dementia and the other users. PWD3, though having some hearing issues, exclaimed that the sounds were very nice to hear and enjoyed his experience. Furthermore, when he heard the sounds of waves crashing, at first could not pinpoint what these sounds were, guessing it sounded like heavy winds and stormy weather as he continued to touch the area. When he heard the sounds of leaves of trees rustling, and birds chirping, he looked over at the laptop from which the sounds played, paying attention to the chirping of birds, however, did not verbally express anything.

6.2.2 Connecting through touch

More connection between the person with dementia and their caregiver was developed through touch. Since there were different types of textures stitched onto the cloth in either 2D or 3D representations ranging from circular to curved shapes giving them range to use one finger to all fingers. With the textures being so familiar, which could be found similarities of it found in their living space. C2 nudged PWD2 to touch separate areas to gain his feedback and asked him questions such as "Doesn't this remind you of...".

PWD3 kept coming back to touch the replica of leaves, expressed emotions of liking, and

Figure 18: PWD3 browsing his fingers on the waves which he described as nice to touch, reminding him of little roads

curiously asked "I want to know where these leaves came from, what kind of tree?" The expert and researcher present there explained we were not aware, and immediately understood and accepted by words of affirmation and nods. Furthermore, while touching the lake, the replica of waves where is stitched in 2D into the flexible pad, he claims this feeling like "little roads" expressing how it is nice to keep touching and follow the lines (see Figure 17).

After browsing his fingers through the cloth, we asked him "What he was thinking and feeling" He replies saying he lives very close to the airport and doesn't come across nature all the time. However, on his way here he has the opportunity to experience such a view in reality. Moreover, touching through the trees, rocks, and bushes, he said "Whenever I walk through woods, I always take the tiny roads with trees and never the proper roads" stating he enjoyed being outside, in nature. In addition to this another aspect that intrigued him was the replica of mud, which was a cloth stitched bag, to whose interior a sponge was stitched to give it a soft, mushy touch. Feeling this, PWD3 expressed "this is really nice to sit on" and laughs for a bit, proceeding to say "to even lie down" (see Figure 18).

7 DISCUSSION

The results and observations presented above provide insight into how tactile expression coupled with some natural soundscapes cued meaningful conversations, and non-verbal expression encouraging them to playfully engage amongst themselves as well as the exterior world. TouchME is meant to be integrated into the homes of people with dementia and their loved ones, usually to connect with people who visit their homes in order to create a relaxed environment, reduce anxiety, and uplift their moods only to improve their quality of life. Moreover, if polished better, this can also be integrated into care homes for people with advanced dementia, placed in the common space. It is interesting to observe each person reacts very differently and each time the perceptions are perceived differently depending on surroundings, emotional well-being, and interactions.

Figure 19: PWD3 touching the replica of "mud" to give feedback that it is very soft to sit and lie down on

The natural soundscapes are there to evoke non-verbal expressions associated with verbal expressions that serve as conversation starters. There have been significant, even if minimal, shows of how sounds also play a role in evoking similar responses of reminiscence which is also visible in the observational studies that were conducted. Furthermore, touch acts as an engaging element to be able to activate movements encouraging playful and curious interactions provided by the various textures. Furthermore, visual perception also acts as a prompt for memories.
Furthermore, due to various distractions in the surroundings, however, this still initiates a dialogue and fuels the connections made by these aspects. This also plays a cue on different ways people inherently pick up audio interpretations, especially while acquiring a tactile expression. Moreover, there is no right or wrong in this process, hence, every interpretation is up to the users, with the freedom to create their own meaningful experiences. In addition to this, various textures provide a grasp to help people with dementia to be invited to experience this tool, as well as, to fidget. Being tested in an informal setting, facilitating a multi-sensory perception articulated by technology, gives them space to relax, enjoy and playfully interact.
Results from the studies show that people with dementia who lack the ability to verbally express themselves, do so through facial and body expressions such as smiling, nodding, relaxed movements, curious movements, opening and closing of eyes, dialogues made with people in their proximity, touching people in their proximity when surprised by these elements to express themselves and so on. This tool only helps to improve the quality of well-being, in the hopes to reduce apathy and assert social cohesion.

8 FUTURE WORKS

Throughout this process, there have been a few misdirections and cut short while achieving various elements. Hence, this section is devoted to describing the implications of the multisensory perception of design in the future, to be integrated into care homes. Firstly, it is ideal for this to be an e-textile rather than being placed on an electronic touchpad, allowing the user to place the cloth on themselves as well as flow onto the person with whom they would be using the cloth to form meaningful connections. This could be achieved b integrating a flexible conductive surface called velostat acting as a touchpad in itself. On this surface, one can attach electronics that connect the touch sensor to the Arduino and Pro-

cessing sketch. The speakers could either be connected to the cloth itself or use an external speaker for better sound quality. Furthermore, the cloth would be expanded in order for it to be held personally in close proximity to multiple users. Another important aspect is the element of personalization. The goal is to be able to provide an array of palettes to choose from, interact and create connections with. Hence, this could range from stitched clothes not only resembling nature, but including, a busy city, farms with animals, coffee places, restaurants, and so on. Apart from this, there is a separate UI application that would include personalization of the sounds which can be done by their (in)formal caregivers and loved ones. This application, as mentioned above, would be connected with the UI functionality on processing, allowing the users to create their own playlists. This application would have the possibility with other music platforms, such as Spotify restoring a connection and easy transfer (see Appendix)

9 CONCLUSION

In this paper, I present insights from field studies, and scientific research that explored the relevance and importance of multi-sensory expression for people with dementia. The findings presented above, contribute further and support existing research describing the importance of multi-sensory expression. However, this expression is commonly construed to environmental settings, with a minimal outlook into textiles to provide this experience. However, with the results mentioned above, it shows ways in which it elicits meaningful connections adhering to imply social cohesion in a social setting. With this paper, I would like to start a discussion into multi-sensory experiences in care homes as well for advanced stages of dementia. My understanding would be that this proves more helpful for a more progressive stage of dementia. However, more research is needed in this domain to conclude explorative findings about multi-sensory perceptions through textiles, investigating the potential importance of dementia care. This work aims to inspire future design research in day-to-day care settings that involve both people with dementia and their loved ones and/or formal caregivers.

10 APPENDIX

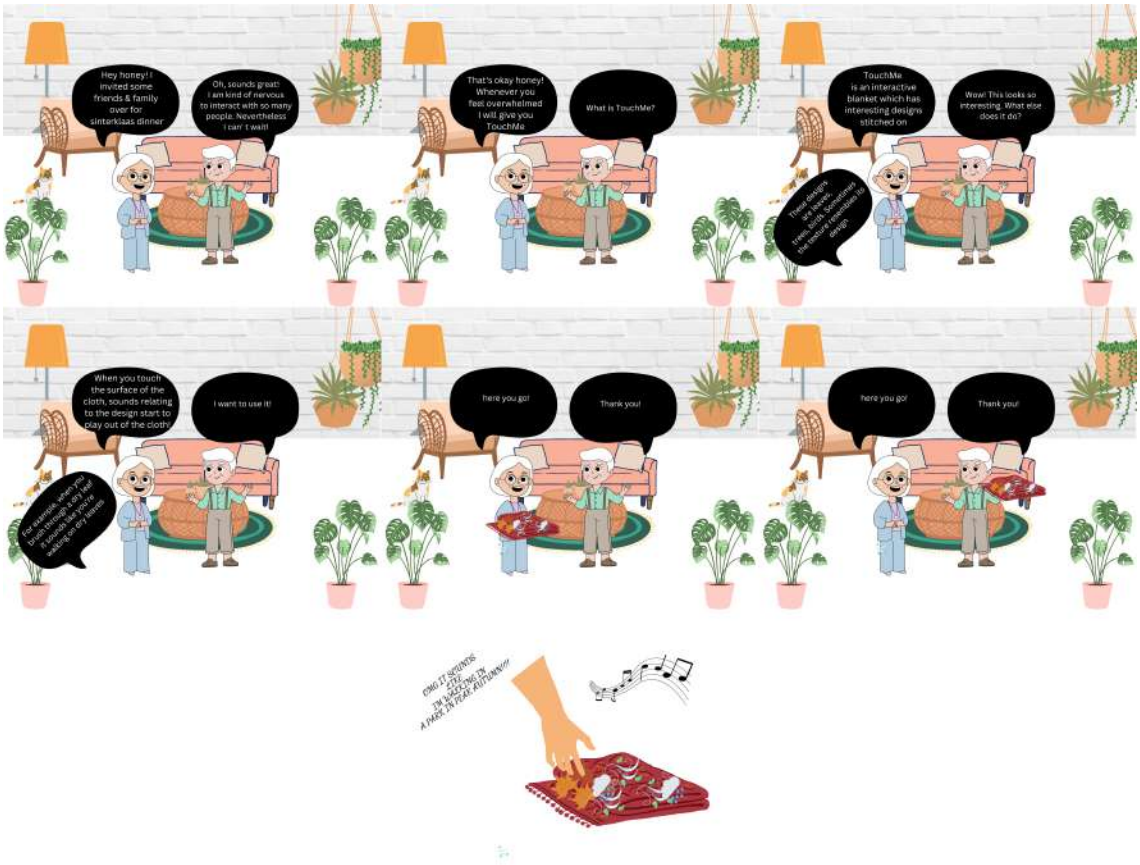

Figure 20: Storyboard of Final Iteration

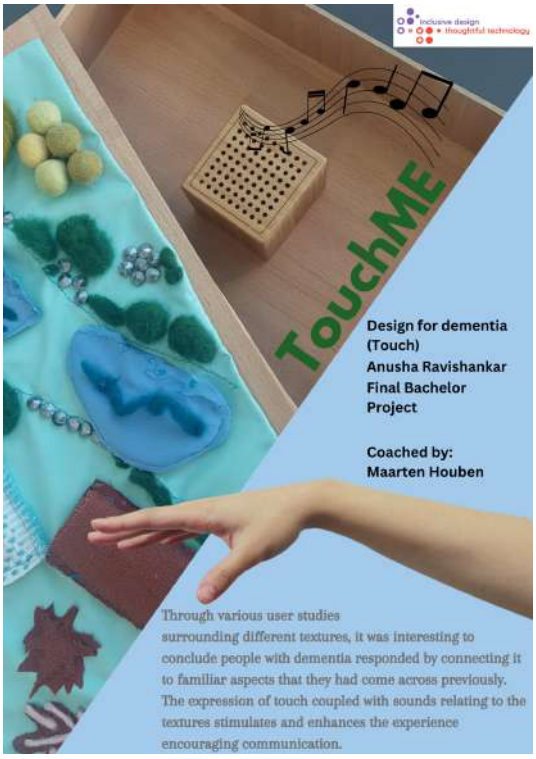

Figure 21: Main Poster for the Demo Day

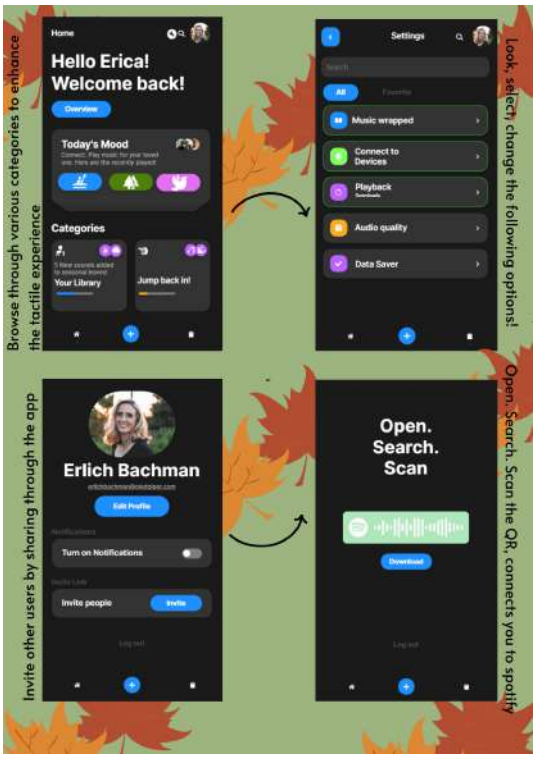

Figure 22: The poster which shows the UI application mentioned in Future Works

```
#include <Adafruit_MPR121.h>
#include <Wire.h>
#ifndef _BV
#define _BV(bit) (1 << (bit))
#endif

// You can have up to 4 on one i2c bus but one is enough for testing!
Adafruit_MPR121 cap = Adafruit_MPR121();

// Keeps track of the last pins touched
// so we know when buttons are 'released'
uint16_t lasttouched = 0;
uint16_t currtouched = 0;

void setup() {
  Serial.begin(9600);

  while (!Serial) { // needed to keep leonardo/micro from starting too fast!
    delay(10);
  }

 //Serial.println("Adafruit MPR121 Capacitive Touch sensor test");

  // Default address is 0x5A, if tied to 3.3V its 0x5B
  // If tied to SDA its 0x5C and if SCL then 0x5D
  if (!cap.begin(0x5A)) {
    Serial.println("MPR121 not found, check wiring?");
    while (1);
  }
  //Serial.println("MPR121 found!");
}

void loop() {
  // Get the currently touched pads
  currtouched = cap.touched();

  for (uint8_t i=0; i<12; i++) {
    // it if *is* touched and *wasnt* touched before, alert!
    if ((currtouched & _BV(i)) && !(lasttouched & _BV(i)) ) {
      Serial.println(i); //Serial.print(" touched");
    }
    // if it *was* touched and now *isnt*, alert!
    if (!(currtouched & _BV(i)) && (lasttouched & _BV(i)) ) {
     //Serial.println("       released");
    }
  }
```

```
    }
  }
  // reset our state
  lasttouched = currtouched;

  // comment out this line for detailed data from the sensor!
  return;

  // debugging info, what
  Serial.print("\t\t\t\t\t\t\t\t\t\t\t\t\t 0x"); Serial.println(cap.touched(), HEX);
  Serial.print("Filt: ");
  for (uint8_t i=0; i<12; i++) {
    Serial.print(cap.filteredData(i)); Serial.print("\t");
  }
  Serial.println();
  Serial.print("Base: ");
  for (uint8_t i=0; i<12; i++) {
    Serial.print(cap.baselineData(i)); Serial.print("\t");
  }
  Serial.println();

  // put a delay so it isn't overwhelming
  delay(100);
}
```

Figure 23: Arduino code for Touch Sensors

```
import processing.sound.*;
import processing.serial.*;
SoundFile Forest;
SoundFile Autumn;
SoundFile River;
Serial myPort;
int lasttouched = 0;
int currtouched = 0;
int i;
//Adafruit_MPR121 touch;

void setup () {
  String portName = Serial.list()[0];

  myPort = new Serial(this, portName, 9600);
  if (myPort.active() !=true) {
    println(" port not available");
  }
  //touch = new Adafruit_MPR121("i2c-1", 0x5a);
  Forest = new SoundFile(this, "Forest.wav");
  Autumn = new SoundFile(this, "Autumn.wav");
  River = new SoundFile(this,   "River.wav");



  //Forest.play ();
}
void draw()
{

  int mp3sound1;
  if ( myPort.available() > 0)
```

```
 {
  String inString = myPort.readStringUntil('\n');
  if (inString != null) {
   println(inString);

   mp3sound1= Integer.valueOf(inString.charAt(0)) - 48;

   println (mp3sound1);

   if (mp3sound1 == 6) {
     Forest.play();
     Forest.playFor(5);
     Forest.stop();


   }
if (mp3sound1 == 8) {
      Autumn.play();
      Autumn.playFor(5);
      Autumn.stop();
}
if (mp3sound1 == 10) {
      River.play();
      River.playFor(5);
      River.stop();
}
}
  }
```

Figure 24: Processing code to connect with Arduino code and play the respective sounds

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